The Fruita Paleontological Report

BUREAU OF LAND MANAGEMENT
GRAND JUNCTION, CO 81501

THE FRUITA PALEONTOLOGICAL REPORT

September 10, 1977

Grand Junction District
Bureau of Land Management
Grand Junction, Colorado

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INTRODUCTION

In 1976 the Grand Junction District Office submitted a Management Plan for the Fruita Paleontological Quarry based upon the recent mammal fossil finds of Dr. George Callison and dinosaur finds of Mr. Lance Eriksen. (BLM, Grand Junction.)

As a result from the 1976 submission, the Grand Junction District was funded to assess the significance of the quarry.

On March 28-29, 1977, BLM, Grand Junction hosted a paleontological workshop designed to provide an assessment of the Fruita paleontological locality and recommendations consistent with their significance.

Participants in the workshop included Paleontologists, representatives of local interest groups, the National Park Service, and Bureau of Land Management personnel.

During the summer of 1977, Dr. Callison collected additional significant fossil material; a description of his finds is included.

While the management plan was being constructed BLM patrolled the quarry. In August our patrol reported that a bulldozer was entering the quarry to construct roads to drill pads per the 1872 mining law. Dr. Callison was working in the quarry at the time. The bulldozer managed to construct a significant amount of roadway before the machine broke down.

BLM immediately went to court and obtained a Restraining Order. Simultaneously we filed a Protective Withdrawal in Washington, D.C. to remove the quarry from any unauthorized activity.

Dr. Callison examined the road and concluded that no fossil damage occurred. A management plan prepared by the Grand Junction District, including the paleontological workshop recommendation has been submitted to the Colorado State Office.

SPEAKERS

Tom Owen	District Manager	BLM	Grand Junction, CO
John Crouch	Archaeologist	BLM	Grand Junction, CO
Gary Matlock	Archaeologist	BLM	Denver, CO
Dr. G. Edward Lewis	Paleontologist	USGS	Denver, CO
Dr. Nicholas Hotton	Curator of Fossil Reptiles	Smithsonian Institute	Washington, DC
Dr. George Callison	Associate Professor of Biology & Research Associate in Vertebrate Paleontology	The California State University & Colleges	Long Beach, CA
Dr. Peter Robinson	Director, University of Colorado Museum	University of Colorado	Boulder, CO
Dr. George Gaylord Simpson	Professor of Geosciences, University of Arizona Professor of Vertebrate Paleontology emeritus, Harvard University, Curator of Vertebrate Paleontology emeritus, The American Museum of Natural History	University of Arizona	Tucson, AZ
Russ King	Superintendent	Dinosaur National Park	Jensen, UT
Beverly Goodrich	Director	Historical Museum & Institute of Western Colo.	Grand Junction, CO
Robert Barry	Recreation Planner	BLM	Price, UT
Lance Eriksen	Paleontologist	Historical Museum & Institute of Western Colo.	Grand Junction, CO
Henri Bisson	Interagency Planner	BLM	Grand Junction, CO
Robert Benton	Superintendent	Colorado Nat. Monument	Grand Junction, CO
Dr. Bruce Rippeteau	Archaeologist	State of Colorado	Denver, CO

THE FRUITA PALEONTOLOGICAL QUARRY

1. BACKGROUND

A. Location

The Fruita Paleontological Locality is located in T1N R3W, Sec. 24 N½ NW¼. The area is 3 miles southwest of the town of Fruita, Colorado, and 3 miles northwest of the entrance to the Colorado National Monument. (Overlay attached.)

B. History

The area north of the Colorado Monument has long been used for excavating dinosaur bones. The earliest known significant finds were made by the late Elmer S. Riggs of Columbia Museum, now the Chicago Natural History Museum. In 1900 and 1901, Riggs removed numerous parts of dinosaurs, namely the Brachiosaurus, Apatosaurus, Diplodocus, Camarasaurus, and Morosaurus. Many amateur, as well as professional, paleontologists have been utilizing the area in and around the Colorado National Monument for over 80 years. As the finds increased and the significance of the quarry became more apparent, more work and further investigations were carried out. During the last 10 years, interest in the Fruita quarry has come from Harvard University, the University of Wyoming, the University of California at Long Beach, the Historical Museum & Institute of Western Colorado, the University of California at Berkeley, and the Museum of Northern Arizona.

The fossils excavated from this area are exhibited and studied in museums and institutions in both Europe and the United States.

C. Geology

The Fruita Paleontological Locality exists in the Morrison Formation, deposited in the late Jurassic age (145 million years ago). (U.S. Geological Survey) There are two members of the Morrison, the earlier Salt Wash composed of interstratified lenses of sandstone, siltstone and mudstone (reddish brown to greenish grey), and the Brushy Basin Member composed of variegated siltstone, mudstone, bentonite clay and small amounts of sandstone and conglomerate.

The earlier Salt Wash has much coarser sediments as a result of alluvial, or stream channel deposition, as compared to the much finer sediments of the Brushy Basin caused by fluvial, or flood plain deposition.

2. RESOURCES AND THEIR SIGNIFICANCE

A. Mammals

The aspect of the Fruita locality of world significance is the recent discovery of mammal fossils. The mammalian fossils were discovered by Dr. George Callison in 1976. (personal communications)The fossils were classified as a primitive prototherian mammal from the Jurassic and probably related to the Triconodant family (per phone conversation with Dr. Callison, September 1, 1976 and letter of September 7, 1976).

Dr. Callison observed that the Salt Wash member of the Morrison Formation extends only to this area and does not extend to the Como Bluffs, Wyoming area, thereby creating a stratigraphic situation in which the mammal-like animals found in Como Bluffs would be younger than mammal-like animals found here in Fruita has been offered. This may hold true for the finds at Canon City as well.

Examinations of the recently excavated mammalian fragments by prominent paleontologists have supported Dr. Callison's observation that this locality is of world significance.

In addition, Dr. Callison located an intermediate sized Rynchocephalian from the early Jurassic related to earlier forms found in the Triassic (Kurten).

Dr. George Gaylord Simpson summarized the known localities in the world where early Jurassic mammals occur, "one in England, three in Portugal, one in Africa and two in North America" (p. 28). In assessing the Fruita locality, Dr. Simpson stated, "It (the Fruita locality) has an interest which is really world-wide and in many different respects" (p. 29). And, to the question: does "the apparent quality of this site, have international implications in terms of paleontological?" Dr. Simpson replied: "Yes, very decidedly so" "clearly yes." (p. 11)

In comparison with the other two localities in North America, the Fruita locality is unique. The famous Como Bluff quarry and the Garden Park locality are not considered as old.

1977 August Assessment. Dr. George Callison was awarded a Natural Science Foundation Grant DEB # 77-14647 to pursue analysis and collecting of the Fruita Paleontological Area. The field work was carried out during the summer of 1977. Dr. Callison offered the following summary of his finds:

"Paleontology of small vertebrates from late Jurassic rocks of North America is severely hampered by the lack of good diagnostic, and complete skeletal materials. Based on preliminary surface collections during the summer of 1976 the Fruita Paleontological Area showed tremendous promise of providing important and significant skeletal and geological information about small, late Jurassic vertebrates. So far, during the summer of 1977 intensive surveying, quarrying and collecting at the Fruita Paleontological

Area have borne out initial paleontological expectations and the prospects for continuing success is excellent. Some preliminary tabulations of specimens collected documents this success.

	1976	1977
SMALL REPTILES:		
a.	Turtles: several disarticulated and broken shell plates.	Several more disarticulated and broken shell plates plus ½ shell and another shell with hind limbs, girdle and tail articulated.
b.	Crocodilian: one partial skeleton and two jaw fragments.	Seven partial skeletons of at least three species including two that appear to be Hoplosuchus (previously known from only one specimen).
c.	Rhynchocephalians: two partial skeletons, four additional jaw fragments.	One skeleton including an articulated foot, five additional jaw fragments.
d.	Other: a few miscellaneous small bones from two localities.	Many miscellaneous small bones from four localities.
MAMMALS:		
	Three jaw fragments, one with crowns on teeth.	One jaw fragment and some unidentified elements.
FISH:		
		Two amiod fish vertebrae from Opal Hill. A Crocodilian tooth and some turtle parts.

It must be noted that the organizing operation produced three partial skeletons. Additional surveying nearby resulted in the discovery and collection of the many additional specimens and indicates that the productive zone at the Fruita Paleontological Area is quite extensive. Thus, continuing work at the Fruita Paleontological Area will likely yield many more fossils of small vertebrates including an occasional exceedingly rare mammal." (Personal communications.)

B. Dinosaurs

The Fruita Paleontological Area is and has produced extremely fine Jurassic dinosaur fossils. The fossils are either closely associated or articulated. The 1977 Fruita Paleontological workshop assessment of the dinosaurs -- "is significant but does not appear to have outstanding major potential."

C. Summary

In summary the Fruita locality is the most significant Jurassic mammalian locality in the Western Hemisphere and of worldwide interest to the scientific community. The recommendations that follow are designed to manage the Fruita Paleontological quarry in perspective with the quarry's significance.

3. RECOMMENDATIONS

The recommendations were made to the Bureau of Land Management in response to the following outline:

PANEL PARTICIPANTS

Group 1	Group 2	Group 3
Mr. Lance Ericksen	Dr. George Callison	Dr. Nicolas Hotton
Mr. Russ King	Dr. Peter Robinson	Dr. Ed Lewis
		Dr. George Simpson

Group 1 please respond to topic 2 and 7.

Group 2 please respond to topics 3, 4, and 6

Group 3 please respond to topics 1, 5, and 8

1. Site Significance
    1. World
    2. Local
2. Protection
    1. Vandalism, theft
    2. Erosion
3. Paleontological Guidance
    1. Short term
    2. Long term
    3. BLM/other
    4. Advisory comn.

4. BLM and paleontological expertise
   1. Should BLM obtain a paleontologist on the staff?
5. Excavation
   1. What rate
   2. Research design
   3. Adjudication of applications
6. Interpretation
   1. Type
   2. Responsibility
   3. Respond to museum proposal
7. Curatorial Plan
   1. Whose responsibility
8. Research center - a local-regional facility to aid paleontological effort

Should any of you care to advise BLM on other paleontological topics please feel free to do so.

MANAGEMENT RECOMMENDATIONS FOR THE
FRUITA PALEONTOLOGICAL AREA

Sponsored by:
The Bureau of Land Management
Grand Junction, Colorado

From March 28-30, 1977, a panel consisting of:

Dr. George Gaylord Simpson, University of Arizona
Dr. Nicholas Hotton, Smithsonian Institute
Dr. Ed Lewis, United States Geological Survey
Dr. Peter Robinson, University of Colorado
Dr. George Callison, University of California
Mr. Russ King, National Park Service
Mrs. Beverly Goodrich, Historical Museum and Institute of Western Colo.
Mr. Lance Eriksen, Historical Museum and Institute of Western Colo.

made the following recommendations and assessments pertaining to the management of The Fruita Paleontological Area.

I. SITE - (a - dinosaurs, b - microvertebrates) FRUITA PALEONTOLOGICAL AREA

1.a. Any Jurassic locality productive of dinosaurs is significant, but this site does not appear to have outstanding major potential.

1.b. The site is a promising microvertebrate locality, especially for mammals, possibly of world significance, depending on what is found on further development.

2.a. The site is undoubtedly of great local significance for dinosaurs, to be stressed at the Historical Museum and Institute of Western Colorado rather than at a field installation or near the site.

2.b. Local significance would be in the sharing of world significance. If, as we hope, extraordinary specimens of Jurassic mammals are found, they would make enough scientific splash to receive wide newspaper coverage.

II. DESIGN FOR COLLECTION AND FIELD RESEARCH

1. Stratigraphy and Sedimentology.

A detailed study of the stratigraphic relations should be made

before further excavation, and continued (with sedimentological studies) as excavation goes forward.

2.a. There should be brief exploration all around the butte for dinosaurian material before any quarrying for large animals is begun -- promising leads must be developed first.

2.b. The area and bed where microvertebrates have been found on the surface should be excavated at once and as fast as is consistent with modern procedures. Articulated specimens should be sought, and all excavated matrix should be screen-washed.

3. All collecting permits should be given subject to peer review, with priority for those already working at the sites. There should also be provision for annual reviews and for collaboration with relevant experts in these fields. Provision should be made for ultimate deposit of specimens in an institution well provided with facilities for preparation, curation, and preservation.

4. Plans for further development and excavation at the site must await the results of completion of phases 2.a. and 2.b. above.

III. RESEARCH CENTER

Any decision as to establishment of a local-regional research center would have to await completion of the program outlined in paragraphs one through seven above, and then would depend on developments at other possible sites in this region.

IV. PALEONTOLOGICAL GUIDANCE

1. Short term only

a. There are two sites. The small vertebrate localities should be excavated under Callison's supervision, and

b. The large vertebrate localities under Eriksen. He (Eriksen) can call in Jim Madsen from Salt Lake if necessary.

2. Long term

Periodic prospecting for newly exposed bone under direction of Callison and Eriksen should be done regularly.

3. Consultants should be called in on an ad hoc basis only.

4. Possibly - J. McIntosh
J. Hopson
P. Robinson
F. Jenkins
R. Bakker

V. BLM AND PALEONTOLOGICAL EXPERTISE

5.1. BLM should hire a State level paleontologist with a Ph.D., 5 year post doctoral experience and proven research ability. A list of consultants should be drawn up upon consultation with executive committee of the Society of Vertebrate Paleontology. Consultant list should be oriented towards formation to be worked, e.g., Wasatch, Morrison, etc.

5.2. Job description should allow at least 20% of time for research to allow paleontologist to maintain research capability.

5.3. Paleontologist should expedite permit applications with consultations with paleontological consultants mentioned in paragraph 5.1.

5.4. Paleontologist should coordinate application and permit where apparent conflict or overlap might exist.

VI. INTERPRETATION

6.1. Interpretation should be by scientific publication and by exposition - based upon material recovered. Exposition could include exhibits in the Historical Museum and Institute of Western Colorado and by teaching aids such as films, popular pamphlets, etc.

Exhibits could include environmental reconstruction displays on animal evolution, and geological evolution of the region -- also, how to excavate fossils -- functional anatomy of Jurassic vertebrates.

6.2. The responsibility for technical publication rests with the scientific community.

Public interpretation rests with the Historical Museum and Institute of Western Colorado, Chamber of Commerce, Colorado National Monument, School District 51, and BLM.

BLM should facilitate these projects particularly with publications.

6.3. Cancel as proposed, see 6.1. and 6.2.

VII. CURATORIAL PLAN

7.1. Permit collected materials.

a. Materials collected under Antiquities Act have stipulations regarding fossil disposition.

b. Future material may not be covered under the Antiquities Act, but laws will undoubtedly stipulate disposition of materials.

7.2. BLM collected fossils and need for curatorial expertise. Negative aspects of BLM curatorial efforts include:

a. No presently qualified personal and/or facilities.

b. Duplication of efforts between districts.

c. Accessibility of the specimens.

Positive features of BLM district curatorial efforts include:

a. Paleontological education.

b. "Hands on" approach.

We feel this could be done best with casted (duplicate) materials of originals. This would greatly reduce breakage, damage allowing wide circulation of site specific materials.

7.3. Research quality materials should be housed in an institution where adequate curation is assured.

VIII. PROTECTION OF PALEONTOLOGICAL RESOURCES

Protection from vandalism and theft is a human phenomenon.

1. Temporary protection could include:

a. On-site workers

b. Cover/backfill

c. Fences

2. Long term solutions to theft and vandalism might include:

a. On-site domes

b. Metal grids (erosion allowed)

3. We recommend that BLM encourage educational programs illustrating the positive and negative aspects of amateur activities.

Regarding protection of the resource from erosion, the following avenues of approach might be useful.

a. Regular collecting would be the best approach

b. Backfill

c. Total excavation

Of the above, the most reasonable would seem to be regular collecting of specimens.

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THE FRUITA PALEONTOLOGICAL WORKSHOP

March 28 and 29, 1977

Sponsored by:

Bureau of Land Management

Grand Junction District

Grand Junction, CO 81501

APPEARANCES:

TOM OWEN - Chairman

JOHN CROUCH - Co-Chairman

GEORGE CALLISON

PETER ROBINSON

GAYLORD SIMPSON

NICHOLAS HOTTON

RUSS KING

BEVERLY GOODRICH

LANCE ERIKSEN

ED LEWIS

ROBERT BENTON

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CHAIRMAN: I believe we can get started now. I want to welcome you to what is probably one of the more unusual conferences BLM has ever sponsored. I don't think BLM has ever gathered together more than one paleontologist at one time, and others that can help us with the program. So it's unusual for us and we look forward to it, and I hope you enjoy the next three days. We are looking forward to getting your advice on the particular problem that we have here.

I would like to introduce everybody, and since I have only met some of you for the first time, if I miss on you why, forgive me, but I think I can get everybody straight. On my right is Russ King, who is the paleontologist on the staff at the Dinosaur National Monument. Dr. Ed Lewis, sitting next to him, is the paleontologist with the USGS in Denver. Dr. Nicholas Hotton, with the Smithsonian Institute, Washington, D.C., who just received his 20-year pin for government service and has been to Uravan but not to Grand Junction, so we are glad to have you. And, Dr. George Callison from Tucson, Arizona.

MR. SIMPSON: Simpson.

CHAIRMAN: Oh, all right. Excuse me. I made my first mistake. Gaylord Simpson, who just returned from India and came up here for some warm weather, even though it's going to be a cold day, I'm afraid. Bob Barry with the BLM in Price manages the dinosaur -- what is it, the Cleveland-Lloyd quarry. BLM is in the business of paleontology. That's one of the places that we operate. And Dr. Bruce Rippeteau, who is with the State of Colorado and handles their cultural resources program. Dr. Peter Robinson from Boulder, Colorado, with the University of Colorado, who has done some work on the western slope. Lance Eriksen with the museum here in town is the one, as most of you have seen, who found this skull and has been working on it on this particular site that we are interested in. And, we are glad to have you here, Lance. Dr. George Callison, who is with the California State University. Is that right?

DR. CALLISON: That's right. At Long Beach.

CHAIRMAN: Dr. Callison made the very significant discovery of the mammal jawbone with teeth last year, one of the discoveries which caused BLM to focus some attention on this site. Bob Benton, the Superintendent of the Colorado National Monument, whose boundary is very close to this, who has an interest in it. We

are glad Bob could be here. Beverly Goodrich, who is the director of the museum here in town, the Historical Museum and Institute of Western Colorado, with a degree of anthropology.

We asked her to come because of her expertise in dealing with museums and so forth. John Crouch, my assistant here, is the archaeologist for the Bureau in the Grand Junction district. The two ladies at the back of the room: Sally Crum, whose first day with the BLM is today, and she's going to help out with our archaeology program this summer and we wanted to have her participate in this; and, Sue Hepler, who is an interpretive specialist with the Colorado National Monument.

So there we have our introductions. There may be one or two others that come in later. We'll introduce those at that time. The recorder is John Powers, who is a Court Reporter and will be preparing for all of us the proceedings of our meeting here. What we would like to do as far as the report from the meeting goes, is to have a transcript of the presentations made -- some of you have a great deal of knowledge about this site that we are interested in. The others have knowledge about the field of paleontology and the field of dealing with it as an interpretive device that we believe will be useful to us. The BLM is very, very new at this particular program. That is why we have invited you folks to come here to help us out. The panel participants who we would like to prepare the signed reports with recommendation as explained in the letters to you, are Dr. Robinson, Dr. Callison, Dr. Simpson, Beverly Goodrich, Lance Eriksen, Dr. Lewis, Dr. Hotton, and Dr. King. Those are the ones that we would like to put the report together with your recommendations to us. The others have been invited in to contribute to the discussions and use their expertise in fields to further explain all the problems dealing with this particular site. For the next day and a half we'll be listening to various presentations, having discussions, visiting the site and the local museum. The following day we would like for that group of people that I named to put their heads together and come up with a report. John will explain further the kinds of things that we hope you will address in a report back to the BLM.

The history of the particular problem here is rather short. We have known that this deposit was out here. I guess our people have known about it for nearly a century. But only in the last year have the very significant discoveries, at least that I'm aware of, been made, one by George Callison and the other by Lance. These discoveries lead us to believe that it is an extremely valuable site. And because of those significant finds, we have become more concerned about protecting the site. We have been losing a lot of things out there from vandalism. And, we are concerned that the quarry is

managed properly, and there's where BLM is in a very shaky area. For instance, I don't know how quickly the various deposits should be looked at by paleontologists, or removed, interpreted, this kind of thing. You gentlemen with your expertise, I believe, can give us a great deal of help on that subject. BLM made a proposal to our state office on what might be done with the site. And, the Historical Museum and Institute of Western Colorado has made some proposals, But I believe that any proposal made to the government will only carry weight if we can get the recommendations of gentlemen like yourselves and ladies like Beverly, with your expertise. So that, in essence, is the purpose of our meeting here.

With that, I believe we can get right into the program. John has some statements which he wishes to make, and then we'll start having our presentations. John?

MR. CROUCH: Thank you. We are very glad to have you here. The program is going to be divided into five segments. The first segment is going to be presentations on what has been found recently in the quarry, and circumstances of their preservation. Secondly, we are going to take a trip to the quarry and look at the formations and perhaps we can have some of the paleontologists who found the fossils there explain what they found, and some interesteing aspects of the quarry. Thirdly, we are going to have presentations on quarry management by museums, the Bureau of Land Management in Grand Junction, and the Bureau of Land Management from Utah, followed by several proposals for subsequent management. Finally, the most important part is the analysis and recommendations by the panel and you participants in how you think we should address our problem. After each presentation, please feel free to ask any questions.

With that, I would like to introduce a very fine friend of mine, Dr. George Callison.

DR. CALLISON: Thank you, John.

Three years ago I became more intensely interested in fossils of small vertebrates. Because of these interests and because of my long standing interest in the Mesozoic Era and some of the critical evolutionary problems that are associated with small vertebrates, I became interested also in the Morrison Formation. This group of rocks has a long history of yielding quite a number of large fossil vertebrates (dinosaurs), but only a few fossils of small vertebrates. Because the Morrison Formation covers such a large amount of real estate here in the western part of the United States, embarking on an expedition to look at the Morrison in hopes of finding small vertebrates is an unusually hopeful undertaking.

In order to maximize our opportunities of finding a place that has good potential for yielding fossils of small vertebrates, one of the criteria that I considered was the prospectability of

the area. In other words (in a slightly facetious vein), I was looking for a place that I could crawl around on, someplace that wasn't so vertical that you were likely to fall, and someplace that was fairly comfortable. I always check the texture of the weathered rock to see it it's comfortable on my knees, elbows, and whether the glare is going to be too harsh on my eyes. Eventually I arrive at some kind of an approximation of a place that looks and feels good. Well, in the case at hand there were still other factors taken into consideration; for example, what had been found in an area previously where in the rock section had they been found, and so on, and because of these searches into the literature I was attracted to the Grand Junction area.

But I must confess that the primary attraction resulted from an association I had with a high school teacher from the Fruita Monument High School a number of years ago when I was teaching at an Earth Sciences Institute at Berkeley. It was an institute sponsored by the National Science Foundation for high school teachers of earth sciences, and this particular person, whose name is George Shank, was one of the participants. Midway through the session George says, "Come on over to Fruita some time and we'll hunt dinosaurs on horseback." He raised Appaloosa horses at that time, and that sounded pretty good to me. Well, that hunt never materialized, but I eventually made it to Fruita.

In the process of driving up and down the Grand Valley, stopping in at the city-county planning agency and looking at aerial photos, going up on the Colorado National Monument and looking down in the valley and looking at other places where the Morrison was exposed, we were attracted to several spots, primarily in the valley, that looked like they were moderately easy to prospect. These spots looked like they contained sedimentary environments that might have fossils of vertebrates and maybe even some small vertebrates. We stopped at Riggs Hill and another of the Riggs localities where fossils of dinosaurs had been found, but we didn't find anything that was particularly interesting. As we worked on farther westward towards Fruita we encountered a pyramidal-shaped hill that was intensely dissected and had a generous supply of fairly horizontal exposures that were easily crawled; so we spent several days crawling (and, I might add, broiling in the sun). In the process of doing this, we found signs that there were fossils of small vertebrates. This first summer (1975), which was mainly a reconnaissance (and it included several areas other than the Grand Junction-Fruita area) yielded fossils of small vertebrates only in the Fruita area. We didn't find any fossils of small vertebrates at the other areas we prospected (they included several spots over in eastern Utah and on farther south, here in western Colorado).

So with the Fruita small vertebrat locality in mind, we then applied for a Federal Antiquities Act Permit to come back this

last summer (1976) to surface collect the site. We were granted this permit and we did come back for two weeks. This trip was financed by a small grant in aid from the California State University Long Beach Foundation. (The first summer, incidentally, was financed out of the personal generosity of all of the participants in the field expedition.)

The second summer (1976), with more intensive surface collecting, we were pleasantly surprised to find quite a number of fossils of small vertebrates. A brief list of the specimens found will acquaint you with the diversity of our findings: First there was a partially articulated skeleton of a small crocodilian; next we found several individuals of a new rhynochocephalian; and, then we found three jaw fragments of fossil mammals. In addition to these, we found some parts of turtles, clams, and small snails. So, the point is, we found lots of small fossils and that some were fairly complete, even though they were found on the surface. The site holds much promise for yielding even better preserved specimens of these very rare small vertebrates.

I think the best thing to do right now is to have some slides to show you a little bit more specifically what we were doing and what we found. I hope that my slides will be bright enough in this room so that you can see them. This first slide is a map of eastern Utah and western Colorado with some orange markings that indicate the general extent to which we made our reconnaissance the first summer. One of the places that we looked at fairly carefully was the Yellow Cat mining area south of Thompson and Cisco Junction and north of Arches National Monument in Utah. It's a very interesting place, and it's a place where Stokes -- an earth scientist from Utah -- discovered some vertebrate fossils and fossil plants that he thought were adapted to living in dry environments. Because of his report, I thought, "Hey, that sounds like an interesting locality to examine."; so we visited the site and found several plant fossils and lots of dinosaur bone, but no fossils of small vertebrates. The site warrants further work. We also prospected several exposures of the Morrison on the way into Grand Junction from Utah, finding a nice fossil turtle at a place called Rabbit Valley. We eventually ended up in the Fruita area, as I mentioned earlier. Later we headed south, examined some places around Uravan and Gladell, and then headed on back to California. Although there's a lot of Morrison exposed in southwestern Colorado, much of it is covered with vegetation and slabs of sandstone. Consequently, it is very difficult to prospect for fossils.

This slide is an enlargement of the USGS, 7.5' quadrangle topographic map entitled "Mack, Colorado". It signals where many of our finds were made on this pyramidal-shaped hill. This past summer we collected several anthills in the hopes that the harvester ants would have picked up some of the beautiful little teeth of small mammals, but it looks like they are not that discriminating in

their esthetic tastes. Anthill collecting has been productive in other areas, and maybe it will in the future prove to be productive here, but it hasn't yet. Our best luck was had by just crawling along the surface and discovering entire small bones and bone fragments that had weathered out of the sediments. Our finds were concentrated in one area of this hill, although there were sporadic occurrences all around the hill. It has also been reported that a jaw fragment of a small rhynchocephalian was found over on an adjacent hill called Opal Hill at what appears to be the same stratigraphic horizon. The beds are dipping northeasterly a few degrees, and the Opal Hill site appears to be at about the same level as our site, although it's difficult to check, mainly because the precise location where the Opal Hill specimen was found is not well known. The Opal Hill specimen is of the same species of rhynochocephalia that we found.

Here are a couple of views of our site. This is looking west, a little bit west of southwest, at the hill that has yielded most all of these fossils of small vertebrates. This view is looking south at the ridge that had the largest concentration. The productive layer shown on this tracing of the previous photograph is marked in red and you can see that out on this ridge the productive horizon is covered by very little overburden. We found at this location the major part of a skeleton of a rhynchocephalian, which is a lizard-like reptile. It is fairly small. This particular one probably was three and a half or four feet long. The other rhynchocephalians were found in fine-grained sediments of siltstones, sometimes slightly sandy siltstones, at this same level farther out on this ridge. The mammal specimens were also found there, in association with the rhynchocephalians.

The other specimens were found at the same horizon but lateral to the places where we found the mammals and rhynchocephalian material and were found in association with much sandier sediments. In the case of most of the other specimens, they were found in association with a channel sandstone, indicating perhaps that they were more aquatic in their habits. The other specimens include at least three individuals of a small crocodilian, they include the turtles, they include the clams and the snails. So it appears, initially, that there are two communities represented in the fossils of small vertebrates that were found. One community living farther out on a flood plain away from the stream channels that consisted of the mammals and the rhynchocephalians. The other community living near the stream channels and consisting of the turtles, crocodilians, clams and the snails.

This next slide is an indication of the topography out there, and you can see why we chose this site. It is nice and soft and fairly easy to crawl around on except for an occasional sharp chunk of sandstone that may get lodged in your knee or elbow. My VW van indicates the scale so you can judge the size of features

of the area. The channel sandstone is in this vicinity and it is at the same stratigraphic level of the site where we found the mammals and the rhynchocephalians. The next slide is a photograph that you're not really to notice the detail so much as you are to notice the quantity of materials that have been found. It is the collection of the rhynchocephalian material that was made on the ridge. There are several vertebrae, several limb elements, a few jaw fragments with teeth, some distal limb elements like this terminal phalange with the core for the claw, and some other isolated bits and pieces that haven't been identified because of their fragmentary nature. These other photographs relate to the rhynchocephalian skeleton that was found close to, but not out on, the ridge. It was found just around the corner from the ridge on a slope. This is the specimen where we have associated lower jaws, several vertebrae, and some limb elements.

CHAIRMAN: Excuse me. What is an inch on that thing?

MR. CALLISON: Okay. This is a centimeter. This particular specimen is about three centimeters long, so these are all very small items. These jaw fragments here are, well, a little over a centimeter long, so they, too, are very small. These limb elements, a few centimeters. One of the significant factors of this material is that its preservation is generally quite good in spite of having withstood a fair amount of weathering. The other significance is that we are finding here associations of elements belonging to single individuals, finding strings of vertebrae, and finding limb and jaw elements associated with the vertebrae. We are finding fairly major parts of skeletons, even after they have weathered out on the surface.

This slide shows the jaw of a modern rhynchocephalian. It is the only living species of a group that originated over 180 million years ago. It now lives off the coast of New Zealand and in several zoological parks. Rhynchocephalians, as you might guess, were once much more widely distributed in the world. There is at two other localities in the Morrison, a close relative of the living species. It was described earlier in this century. It has teeth that are practically identical in shape and in number to the modern specimen. The configuration of the jaw is very close to the modern species and presumably it did similar things in the environment. It may not have inhabited the burrows of petrels and it may have had some other peculiarities, but at least morphologically it looks very much like the modern species. Well, this is another view of the modern species showing a somewhat peculiar arrangement of the teeth. This is sort of a mechanic's eye view of the palate. Pretend that you are on one of these mechanic's scooters and you have scooted into the mouth of one of these animals and you're lying on your back looking up at the palate. This is what you would see in the skull: a row of teeth around the margins of the jaws and then, extending back alongside that marginal row is an extra row of teeth

between which the lower jaw teeth occluded. The lower jaw comes up in between and it makes a very effective food processing device for shearing off bits of food that are taken in. Well, in the other specimen, the other species of rhynchocephalian that's found at Como Bluff and Canon City, the ones that I alluded to a few minutes ago, the teeth are very much like this. Because the teeth are very much like the modern species, presumably the rest of the skull is rather like the modern species as well. The Fruita rhynchocephalians don't look like this at all. The teeth are much more broadly expanded transversely, and because of this change in tooth morphology it presumably had different feeding habits and probably other habits were different as well. So this is yet another kind of a rhynchocephalian that was present here in the late Jurassic rocks in North America.

These photographs show you two different aspects of one of the three mammalian specimens that we found. This is the only one that had teeth. It is a chunk of the lower jaw and the size of this specimen is quite small. It is less than a centimeter long, but you can see that there are teeth anchored in the jaw sockets. This is an occlusal view; that is, you are looking down on top of the tooth. It's a tooth that's not in terribly good shape; the main cusp and one of the accessory cusps have been broken. Nevertheless, it is a tooth that is recognizable as being from a mammal. Unfortunately, it's a tooth that is notoriously non-diagnostic. That is, it's one of the teeth that you can't make a whole lot of sense out of, in terms of where to put this organism taxonomically. And because of that, the precise taxonomic allocation of this specimen is not well understood. Some of the specialists who have looked at this specimen have thought that it's probably a previously unknown Prototherian. A Prototherian means that this belongs to the group of mammals to which living monotremes (spiny anteaters, platypusses, and the like) are allocated. It's a group of mammals that enjoyed a fair amount of success in the Mesozoic Era and there are quite a number of adaptive types of mammals belonging to this group. Some appear to have been fish eaters, some appear to have been insectivorous, and some appear to have been granivorous; the group nowadays is relatively insignificant among the mammals. And the Fruita specimen may belong to that group. This next slide is a restoration of a primitive mammal, not necessarily a Prototherian, but something that may be fairly close. This particular one is a late Triassic mammal that was restored in this rather interesting pose. I just wanted you to see what some people think of these mammals may have looked like.

One of the best specimens that we discovered is the skeleton of a small crocodilian. Modern crocodiles and alligators originated some time in the late Jurassic, presumably, and they probably originated from a group of crocodilians that were later to become extinct. Early in the Tertiary Period, they had quite a variety of lifestyles and body plans. Some of them were quite small; the Fruita specimen may be one of these crocodilians that

was somehow allied to the ancestry of modern crocodilians. It's something that we don't really know. But the point here is that the history of modern crocodilians is not very well understood, and that modern crocodilians did take their origin probably in the later Jurassic era times, perhaps slightly before then, and so the potential for finding modern crocodilian ancestors is fairly good when you're looking in the late Jurassic rocks. And we found some crocodilian specimens, a couple of jaw elements, the teeth of a very small one, and the skeleton. This slide is a modern juvenile Mississippi alligator, just to show you the size and the shape of the bones and the distribution of teeth. A couple of the specimens we found were of about this size. This particular individual was about twenty inches long. I compared these vertebrae with the vertebrae of this particular specimen and they were almost identical in size, which may mean that this individual, when you see the whole thing would have been about twenty inches long. Represented in this block of sandstone are several vertebrae from the front part of the animal, a few fragments of the rear part of the skull including part of the maxillary with a couple of teeth on it, part of the shoulder girdle and an elbow, part of the upper arm bone and part of the lower two arm bones. So it's a rather nice specimen. Again, it's significant in that here we are finding bone of fairly good quality in an articulated condition right on the surface. This happened to be partially weathered out. We saw about four vertebrae on the surface and just picked it up. It was sort of a nodular piece of sandstone.

That's a turtle, just to remind me to say that there were turtles there that we also found. The take-home lesson of these slides is that there is an abundance and a variety of specimens that were found, and that many specimens are new species of potentially evolutionarily significant vertebrates. We are hopeful that because of the abundance of material we found on the surface, that there will indeed be something under the surface. It is our desire to begin excavating this coming summer. I'll be happy to entertain any questions that you all might have.

CHAIRMAN: Speaking from, say, the United States as a whole, I'm interested in knowing the significance of this particular area, of the kinds of things that you're finding. Would this be one of the highly significant areas of the United States, and how much so?

DR. CALLISON: In my opinion, yes. And the reason I say that is that in the later Jurassic rocks there are two other primary localities that have yielded fossils of small vertebrates in any abundance at all. One of them has a tremendous amount of small vertebrates and this is the Como Bluff, Quarry Nine locality in southeastern Wyoming (near Laramie). Quarry Nine has yielded several hundred jaws of small mammals. Professor Simpson has done extensive work on the fossils of small mammals that were found

there. Incidentally, I think only one of the small mammal specimens at Quarry Nine was found on the surface and in the quarrying operation encountered the rest. In addition to the mammalian specimens, there are fossils of amphibians and fossils of lizards and some other small vertebrates including some fishes; they are in good abundance. I think that it is fair to say that the quality of the material is moderately good. It is almost invariably disarticulated, however, and consequently most of the work that has been done on the jaws and teeth were the diagnostic features are . . .

CHAIRMAN: Are you talking about here or . . .

DR. CALLISON: I'm talking about the Como Bluff locality.

The other locality is north of Canon City about twelve miles, near a place called Garden Park, and it, too, has yielded some fossils of small vertebrates. It has yielded some of these rhynchocephalians that we have been talking about. The Como Bluff locality also has jaws of these rhynchocephalians plus vertebrae and some other post-cranial materials, but they haven't been identified because I think nobody has taken the trouble to do it. There is a great need for articulated reference material. But at Garden Park the abundance is much, much less than it is at Quarry Nine.

MR. ERIKSEN: Have you been to Garden Park?

DR. CALLISON: I have been to Garden Park, but I have never prospected for small vertebrates.

DR. SIMPSON: I may go into this in a bit more detail later, but there is in the world another very rich, small vertebrate late Jurassic locality complete with mammals and complete with other things, rather similar to the Quarry Nine find. That's at Girlson Bay in southern England.

DR. CALLISON: Southern England?

DR. SIMPSON: Yes. On the so-called Isle of Purbeck. It's a peninsula. It's quite similar. It has many similarities to the Quarry Nine.

DR. CALLISON: The materials are primarily disarticulated.

DR. SIMPSON: Yes, but so is Quarry Nine.

DR. CALLISON: But in North America it's primarily the Canon City site and the Quarry Nine.

DR. SIMPSON: North America and Europe were probably the same continent, even though it was a long distance from Wyoming to southern England when it may have been a continent.

MR. CROUCH: The unusual feature of this quarry here is it's apparently articulated in greater abundance.

DR. CALLISON: Articulated or closely associated. Some that we have found have been articulated; some we found that appeared to be from the very same individuals and closely associated.

MR. BENTON: Doctor, I just want to try to pin you down just a little bit more. If I heard your answer correctly there, you're saying that you don't have any problems, at least at this time, in saying that apparently the Fruita paleo site is nationally significant of the first order.

DR. CALLISON: That's my opinion, and I think these other gentlemen are even better qualified than I to comment on that because of their experience.

MR. BENTON: The second question would be, then, is the quality of it, the apparent quality of this site, have international implications in terms of paleontology?

DR. CALLISON: Would any of you care to comment on that?

DR. SIMPSON: I would say yes, very decidedly so. And if I may be able to speak a little longer later on in this meeting, I'll go into some of the reasons for that. But the answer is clearly yes.

MR. ERIKSEN: I would think so.

DR. LEWIS: Did you find anything that might be related to Hoplosuchus in the materials that you found?

DR. CALLISON: I can't tell you yet whether there are things other than the rhynchocephalian, the little crocodilians and the mammals. Those are the only things that we have.

DR. LEWIS: I think that Hoplosuchus are considered crocodilians.

DR. CALLISON: The crocodilian material that we have so far, at least as far as I've been able to determine, is not very diagnostic, the parts that we have. And because of the abundance of this material that we found on the surface, perhaps we'll find more complete material under the surface. I talked to Wann Langston (University of Texas) about this last fall. He said, "Find some palates and find some scutes and then we'll be able to talk."

DR. LEWIS: I would be interesting to know, in that light, of course, Dr. Gilmore thought at first that it was another type of

animal, but it could be a juvenile of some better known crocodilian type. And I was also curious to know if there were any similarities to the Homeosaurus, the European Homeosaurus.

DR. CALLISON: No, it's not like the Homeosaurus. Homeosaurus does not have the transversal expanded teeth, they are broadened from front to back. They are just not oriented in that plane and they are much more delicate. This appears to be a much more massive beast than the Homeosaurus. The jaws are very powerfully constructed. They have a lot of dermal sculpturing on their surface, rather like some crocodilians. They have very stout teeth that are very broad and heavily constructed. They appear to be able to process some fairly tough materials, but I don't even have the faintest inkling about what kind of materials they were eating. They are very unusual. Now, there is another specimen of a very similar beast that's known from the lower Cretaceous of western Montana. It's a specimen that Olsen described a few years back, I think in the early 60s, as a Trilophosaurid. It's called Toxolophosaurus, and Jim Hopson and Gaylord Throckmorton (University of Chicago and the Field Museum) recently redescribed it. It's not published yet, as far as I'm aware, and it's very close to this thing we have. It may be in the same genus, it's that close. But it's from the lower Cretaceous, slightly younger than what we have here, and appears to have had similar habits because of similar morphology. It's represented by two lower jaws and it's, according to Hopson and Throckmorton, definitely a sphenodontid rhynchocephalian.

DR. RIPPETEAU: Have you had occasion to estimate the total easily accessible volume embracing this?

DR. CALLISON: I haven't attempted to do this, other than on this one ridge that has yielded most of the specimens. There appear to be 75 square meters of the productive horizon that we could get at fairly easily just by stripping off a meter or less of overburden. To get at the rest of the horizon it goes into the hill and that would mean some other special techniques if we were to attempt to do that.

DR. RIPPETEAU: How thick are we talking about?

DR. CALLISON: I'm not positive, but it looks like it's coming out of a layer that's just a few centimeters thick. It's maybe ten or fifteen centimeters thick, although because of the nature of the collections that we have done so far, we haven't been able to pinpoint exactly how thick it is. Yes?

MR. KING: George, maybe it would be instructive if you could give an estimate of the size of your sample in the two weeks of collecting, and how that might compare with all of the late Jurassic small vertebrates, the remains that are known so far, if you can do that.

DR. CALLISON: I can't do that very competently because I'm not that familiar with the specimens from the rest of the world. I have seen most of the late Jurassic collections from North America, however, and what we have is but a small sample compared to what has been taken from Quarry Nine. There's been a very large volume of material taken there, but as I mentioned earlier it's primarily disarticulated. But what is there, like the mammal jaws and things, are very exquisite, beautifully preserved little jaws, nice specimens, but they are not associated with skulls, nor are they associated with vertebrae or limb bones. At least these associations haven't been mentioned and the material that I have seen looks like it would be very difficult to make any association like that. So the emphasis that I'm trying to place is that the quality of the Fruita material is very good, and because of the articulated nature of it, if we find more that is articulated, maybe more sense can be made of these other sites from which the disarticulated fossils have been found. By finding an entire individual, you can say, "This kind of a leg bone is associated with these kinds of jaws and these vertebrae are also associated with those parts." And then when you find these in the disarticulated condition you can identify them more precisely, and extra biological information can then be gained from that.

DR. ROBINSON: Do you have any significant concentration of bones in your outcropping area?

DR. CALLISON: There appears to be, out on that ridge, two fairly productive areas, all within that same horizon, from which the bones have been weathering. They are not very large in aerial extent, like I said. The whole ridge, as far as the productive horizon is concerned, has probably 70 to 80 square meters of area, and within that entire area there are two fairly hot spots that appear to be yielding a lot of material. But we found several dozen bits and pieces, some of them are quite complete and others aren't. But it's all been weathered out stuff.

CHAIRMAN: Let me ask one more question. From the standpoint of protecting that site, I get the idea that the kinds of specimens you're interested in would not be very easily recognizable to even -- well, to certainly a casual trespasser out there. But even somebody who tends to look for bones and sell them, this kind of thing, would they recognize the kinds of deposits you're interested in or is there any value to them?

DR. CALLISON: Most people, I think, wouldn't. In the case of the specimen that was found on Opal Hill, the hill adjacent to the one that we are talking about here, that was found by an amateur and it's a small posterior dentary fragment; a small jaw fragment with some teeth in it. And in that case, an amateur did find it. But I suspect that most people out there wouldn't see it. As a matter of fact, there have been other professional paleontologists

in the area looking, and they didn't find any of these things. So it's very chancy, but it's very unlikely, I think, that anybody would see these materials. They are very small and they are practically the same color as the rocks that they are weathering from. Periodic surface collecting by professionals would greatly reduce the likelihood of the resource being damaged or lost.

CHAIRMAN: Probably from a protection standpoint, then, the important thing would be to try to keep casual visitors from tramping around out there.

DR. CALLISON: That I think would be the biggest problem. I doubt that they would be picking them up and seeing them. Yes, Lance?

MR. ERIKSEN: Is there any lime content in these nodules that you found of the small crocodilian?

DR. CALLISON: I haven't even checked for that.

MR. ERIKSEN: They look very minor to me.

DR. CALLISON: It's a pretty sandy horizon from which we got the crocodilian, but I don't know what the cementing material is in the sand.

DR. LEWIS: How about the radioactivity of that? Are there any concentrations on it?

DR. CALLISON: I have no idea.

DR. LEWIS: That particular formation is being worked pretty heavily right now on the uranium prospects, and no differences, or have you measured it?

DR. CALLISON: Well, as I understand it from Loman's report, there aren't any significant radioactivity deposits in this immediate area. But I really don't know, other than that. I can't comment.

MR. ERIKSEN: I had some of these bones checked out and it's very low, hardly registered.

MR. CROUCH: Our next speaker is Lance Eriksen from Grand Junction, Colorado.

MR. ERIKSEN: This is the first time that I have ever done this sort of thing, so be gentle with me.

Fossil remains in the Upper Salt Wash at Fruita, Colorado are exceedingly plentiful, ranging from mammals to rhynchocephalians, crocodilians, turtles and dinosaurs. There are at least two layers containing dinosaur remains. However, the main concentration of bone lies approximately 35 feet below the Brushy Basin in the Upper Salt Wash member, and is primarily concentrated in the layer of sandstone ranging from two to nine feet in thickness. This sandstone facies appears to lie just under a red overbank which contains microvertebrate fossils. A few feet under the sandstone facies are lacustrine nodules which contain small crocodilian remains. Approximately 30 to 40 feet below the heaviest concentration of dinosaur bone is a layer of sandstone containing dinosaur tracks which are either small theropod or orinthopod or perhaps both. A small amount of fragmented dinosaur bone also appears in the lowest section of the Brushy Basin.

Predator-Prey Ratio. Perhaps one of the most significant features of the dinosaur fauna in the Upper Salt Wash found in Fruita is the abundance of sauropod remains. These seem to equal the remains of theropods. However, a true percentage at this time is difficult to determine because of the dispersing of bone in the flood plain type environment. I do not believe this situation to be that of a catastrophic condition such as the Cleveland-Lloyd quarries. Informal observation of Cactus Park, Rabbit Valley, Black Ridge and Ruby Canyon seem to indicate a high concentration of theropod remains. In other words, whereever sauropod remains are observed, in the immediate vicinity therepod remains are also always found. The Garden Park Quarries at Canon City, Colorado, also in the Upper Salt Wash, have a forty percent therepod to sixty percent sauropod count, judging by the specimens collected by Felsch, according to Marsh's Dinosaurs, authored by Ostrom and McIntosh.

Other Dinosaur Fauna. No small theropods or ornithischians have been discovered at Fruita thus far. Only the partial remains of a stegosaur have been collected and these have been partially prepared. However, most of the bone is grotesque and misshapen and encased in iron oxide, which makes preparation difficult. The most outstanding feature of this specimen is the pubis. The pubis is slightly longer than the femur.

Antrodemus is also present at the Fruita site. In fact, it was the discovery of a partially vandalized Antrodemus that allowed me to secure a salvage permit to collect the Stegosaur and Ceratosaur remains. And much to my surprise, the bone hunters turned out to be one of my best friends, in this case.

Ceratosaurus. Perhaps the most significant dinosaur specimen collected thus far from the Fruita Salt Wash is that of Ceratosaurus. I had previously believed, after consulting with Jim Madsen, that this represented a new species. I am now more

inclined to believe that it is the same species collected from Garden Park by Felsch, (Ceratosaurus nasicornus, Marsh.) Close comparison of the two specimens should be conducted to identify the Fruita Ceratosaurus. If they are indeed the same species, then perhaps the reconstruction of the skull of the Ceratosaurus nasicornus, Marsh, should be reexamined. For instance, the maxillary fenestra is totally lacking in the illustrations according to the Osteology of the Carnivorous Dinosauria by Gilmore. The maxillary fenestra of the Fruita Ceratosaurus is of a considerable size, eight centimeters by four and a half centimeters.

Another difference is in the nasal bone. The illustrations that Gilmore show a relatively narrow bone as compared to the Fruita Ceratosaurus. It would only seem likely that an animal which carries a horn on the nasal would have to have extra durable nasal bones.

In the last few years, some paleontologists have questioned the presence of this nasal horn. Perhaps the lachrymal was displaced upon the nasal and gave the appearance of a horn. I, too, questioned this, but when I carefully studied the photographs in Gilmore from right and left views, there did not appear to be a lachrymal vacuity. Perhaps this was filled in when the skull was reconstructed. This uncertainty gave me more incentive to hasten preparation of the Fruita Ceratosaurus skull. What appeared to Marsh as a nasal horn core, I feel has once and for all been justified by the Fruita Ceratosaurus.

Another interesting feature of this skull is the type of sculpting on the lachrymals. This is very prominent, even more defined than that of the nasal horn core. Is it possible that Ceratosaurus had some sort of a horney projection above the eyes?

Another interesting comparison between the Fruita specimen and Ceratosaurus nasicornus, Marsh, is that the metatarsals of the latter have been fused together, which has been thought to be of a natural condition. According to the Fruita Ceratosaurus, the metatarsals are distinctly singular, with no sign of fusion to the bone. It is possible that the fusion exhibited by the Ceratosaurus nasicornus, Marsh, was caused by injury or perhaps even bone disease.

Along with the skull, four skin ossicles were discovered. One of these appeared to be in place on the posterior along the median line of the skull. Joined with this ossicle, oddly enough, appears to be an articulate portion of some sort of spine. The skin ossicles are little armor plates like are in the back of crocodiles, in their skin.

Preparation by Nature. Dinosaur remains at the Fruita site are primarily in sandstone, making it somewhat difficult and time-consuming to collect. To deal with this, I have to devise an experimental method for partial preparation and collection, which I have termed "preparation by nature". This is described in the

following steps:

1. Remove overburden down to bone layer.

2. The softer sandstone matrix is carefully eliminated from the bone surfaces.

3. All exposed bone surfaces are then painted with glue and allowed to dry, and then coated with fibre glass until hardened before any of the weathering can take place.

4. All harder sandstone around the bone is then exposed for nature's preparation.

5. After the elements have broken down and weakened the harder sandstone, the matrix is worked away from the bone down to the harder sandstone again and the same process is repeated until the bone can be jacketed and safely removed to the laboratory for technical preparation.

The reasons for using this technique are:

1. Limited manpower.

2. Efficiency and thorough separation of matrix from bone surfaces.

With the harder sandstone and oxidization encasing the fossils, it is sometimes difficult to determine the matrix from the bone. The elements see to performing a remarkable job of separating matrix from bone and only a minimum amount of assistance is needed. That's not true. A bit more than a minimum amount is needed.

Recommendations and Goals:

1. The Garden Park and Fruita sites should be compared to determine if the sediments were deposited at the same time, more or less.

2. A sedimentologist should be consulted to evaluate the sediments at Fruita.

3. If possible, potassium argon tests should be performed to determine the exact time period we are dealing with.

4. More study should be done on the predator-prey ratio.

5. Areas outside the Fruita Quarry should be thoroughly prospected to see how far the high percentage of theropods extends.

6. More complete comparisons should be made between the Salt Wash and the Brushy Basin members.

7. Prepare a Ceratosaurus skull for more complete scientific study and make casts.

8. All paleontologists and the Bureau of Land Management should work together and cooperate on all fauna collected from the Fruita area to help determine the ecology of the Upper Salt Wash.

CHAIRMAN: Lance? How would you propose your recommendations be carried out? Are you talking about continuing through the granting of various permits and so on, to paleontologists, or are you just talking about something that the Bureau should sponsor and try to do? Or did you have anything particular in mind?

MR. ERIKSEN: Well, I don't know. I think at this time, this point, I should try and get something more than a salvage permit, maybe, because I think on the one hand it's kind of against the law to work on a salvage permit and really do the digging. I don't know. I'm not much up on this sort of thing. Like I mentioned, the bone hunters were the ones that even got the salvage permit to start with.

DR. LEWIS: What materials do you have, Lance, for a potassium argon radio dating analysis?

MR. ERIKSEN: We don't. In fact, I don't know really if there's enough potassium. I just assume that there is, but I don't know for sure, for getting a dating on it.

DR. SIMPSON: How long does nature's preparation take?

MR. ERIKSEN: Well, I have noticed -- because I had a bone that I just picked up out there. This is quite a long time ago, and I just chucked it outside the door of my house.

DR. SIMPSON: I'm thinking about the stuff that you're leaving out in the field there. Isn't that an invitation to vandals?

MR. ERIKSEN: Yes, it is. The only way that it can really be fully protected is to have somebody on top of it all the time, and get a coat of glue and fiber glass on after each rain storm when it has been cleaned off. There wouldn't be the kind of preparation like that at the Dinosaur National Monument, because it would be strictly in the open, and . . .

DR. SIMPSON: One other point, a quite different point I wanted to make, was this matter of predator-prey ratio, which is a very interesting one from an ecological point of view. I trust that the people that are doing these studies are not going to forget

that predator-prey doesn't apply to dinosaurs preying on dinosaurs. There's a lot of other meat around, and there's evidence that a lot of these mesozoic animals were eaten by small dinosaurs. They would be one bite, but they would be one good bite. There were fish and crocodiles around, and turtles around, and quite a few other things around that the dinosaurs could eat.

MR. ERIKSEN: Right. I'm hoping to find some of these small theropods. Are there any other questions?

CHAIRMAN: I have one more. Are the small mammals that were discussed by Dr. Callison mixed in the same places with the things that you found, with the skulls?

MR. ERIKSEN: Since I really don't know too much about geology, it's hard for me to determine. First I thought I was right on top of the layer where these small fossils came out of. Then I looked at it again and it looked like maybe I was underneath it. And the last time I looked at it, there's a sandstone ledge with the dinosaur bone in it. It runs out right over to where George found this other. And so it's hard to say. I'm beginning to think that maybe it's in the same layer. I don't know. Do you know?

DR. CALLISON: I haven't looked at your slides.

MR. ERIKSEN: It's hard to determine. It is possible that there was a sand bank right there holding all these bones and beyond that maybe some kind of a mud flat containing these things.

DR. CALLISON: The hill is dissected enough that one could tell with a minimal amount of effort, because there's so much of the section exposed on so many of the aspects of the hill, and even though Lance is working around on the other side of the hill from where we are working, it would be a fairly easy job to correlate.

MR. ERIKSEN: To me, it looks a lot different, even in that little space.

DR. CALLISON: Methodologically, there's a fairly drastic change laterally in a fairly short distance, but still you could work out the stratographic relationships, I think, if we were to make a concerted effort to do it.

MR. ERIKSEN: I think this is something that should be done, though.

CHAIRMAN: I have one more question of the same type that we asked Dr. Callison. I'm asking everybody this as well as Lance, but nationally, or internationally speaking, what is the significance

of the site for the kinds of things like you're finding as opposed to what Dr. Callison is finding? How would you assess that?

MR. ERIKSEN: The only thing that I can really say is, it is in the Salt Wash, and as far as I know, there hasn't been a lot of dinosaur fossils taken out. I think the most has probably been from Canon City, hasn't it? That's Upper Salt Wash.

VOICE: Can you say that for sure? Because over at Canon City . . .

VOICE: Geographically, isn't that more or less undifferentiated Morrison?

MR. ERIKSEN: I really don't know. This is all just through hearsay.

MR. ROBINSON: It's perfectly good evidence that west of Canon City is Morrison. There was probably no continuous sedimentation.

MR. ERIKSEN: Is that true? Well, I have never been there. I thought maybe it was more or less laid down at the same time.

DR. HOTTON: In a paper done around 1956 by the survey the Morrison, in particular, is reviewed in detail. And the argument there is that in the west you have got Brushy Basin and Salt Wash, with Brushy Basin on top. But when you get over west, east and north this differentiation breaks down. But they do think that the undifferentiated Morrison resembles the Brushy Basin, and does include time equivalent to the Salt Wash. But because of the more or less uniform methodology, you can't say for sure. It would have to be worked out stratographically.

DR. CALLISON: Let me comment on that for just a minute. Loman, in his report on the geology and ground water of the Grand Junction area, makes mention of some things that might bear on this question. One of the things that he says is that in the Salt Wash, as you look further east at the exposures of the Salt Wash, it becomes more like Brushy Basin in appearance. And if you extend that then still farther over to, say, Como Bluff, it's conceivable that it would take on an appearance that would cause it to not be easily distinguished from the Brushy Basin, if it were present there at all. But I still think there's a big question as to whether it persists across.

VOICE: Craig said that he thought that differentiation, undifferentiated Morrison, did include equivalent, but there was no way to sort it out.

MR. ERIKSEN: This might make it even more important.

VOICE: I agree. The fact that you said youhave got dinosaurs in the Salt Wash is not what you usually find. This is most interesting, right?

DR. CALLISON: It should be pointed out that the small vertebrates also are from the Salt Wash and as such they almost certainly are older than the Como Bluff, and perhaps older than the Canon City specimens.

DR. LEWIS: Also, regarding the importance of it, the Ceratosaurus that Marsh described was a thing that didn't have any other corroborative evidence, and here you have got a fine specimen. So this is one of two such localities.

MR. ERIKSEN: Yes. And also on Black Ridge there was other Ceratosaurus teeth found, so I think this area was probably a good home for it.

MR. BENTON: Again, that question would be an appropriate question that Tom asked, that this undoubtedly has national significance, at least the potential for it.

DR. LEWIS: Absolutely it does.

MR. ERIKSEN: Scientifically for sure.

DR. ROBINSON: I would like to raise a question. Is it conceivable that a distinction should be made between site and the specimen?

MR. ERIKSEN: Could you give me that again?

DR. ROBINSON: In other words, whether it's a significant site. Is it possible that the distinction should be made between the site, that is, the actual location, and the specimens which come out of it? Because I can see situations, as a geological site containing bones, the significance might be different in that sense as against the paleontological evidence gained from the bones.

MR. ERIKSEN: Yes.

DR. ROBINSON: I'm just throwing it out.

MR. KING: I think in that sense it would be up to the BLM to kind of determine how they want to look at the total resource and evaluate it in terms of Dr. Robinson's questions about distinguishing between the site and the specimens.

DR. CALLISON: To me, one of the beautiful aspects of

this site has to do with the association of these very large dinosaurs with these very small vertebrates, and the different lithological properties in the area. You're getting several kinds of information about what was going on in the late Jurassic period right in this one very limited area, and because of these associations, I think it is a unique site. I don't know of any others in the Salt Wash, unless the Canon City one is something like that. But when you have these different kinds of things in association, the opportunity for interpretation is tremendously enhanced.

MR. ERIKSEN: I think this association might help us know a bit more about dinosaurs. The fact that they are there might help to determine the environment.

MR. CROUCH: We have changed from using the word "site", for geologic reasons. We had been using Dr. Callison's term site when we were dealing specifically with his discovery, and we were using Mr. Eriksen's word site. It became confusing. So we just dropped the term altogether and used the word area.

MRS. GOODRICH: My presentation is involved mainly with the interpretation of the site.

The museum has been interested in this area. I shouldn't have said "site", Area. Okay. Mainly because we are the only museum in the immediate vicinity, the only museum of any size, and we are committed to emphasizing the local and regional paleontology. The paleontology of this area probably is one of the most important facts of natural history. We are in a most unique area. Last year when Lance recovered the Ceratosaurus specimen, and when Dr. Callison was out in the area, we started to discuss how this particular area could best be preserved, what the public's needs would be in this, if indeed it did turn out to be a significant scientific area. Vandalism has been a problem. In fact, the Ceratosaurus, while Lance was excavating, suffered some vandalism. Bones were stolen from the site, isn't that right?

MR. ERIKSEN: There was a Sauropod scapula correcoid all together, a beautiful specimen, we even had it covered. So I don't know.

MRS. GOODRICH: Unfortunately, pot hunting and bone hunting both are major weekend pastimes in western Colorado, so we do have a problem out there with that. Also, we are interested in the area of interpretation out here, and last year a proposal was submitted to the Bureau of Land Management which involved several things. Briefly, we had been talking to the Bureau about having a watchman out there. The Bureau did have a part-time person out there and

we submitted that we would help with a warm body to help patrol. In addition, the major points of the proposal were that we would cooperate in developing a working fossil quarry, a visitors' center for interpretation, and along Highway 340 we would put the museum's new building, which is going to be constructed in 1981 according to the current projections. The idea being that we would have three major things in the vicinity of the fossil quarry: a research center for the scientists, a visitors' interpretive center for the public, and a museum of natural history nearby; the three working cooperatively together. It could be a rather significant scientific complex. Since this proposal was submitted, some things have changed. In particular, our situation has changed. We have been faced with the political expediency of changing our site. Some of the rather large donors to the building fund say that they do not want the museum out there, and so we are committed to a downtown location for the museum itself. And this, of course, changed our original proposal rather drastically. The new proposal that we have been talking about involves two points. We can assist with security if it is decided that a watchman might be necessary say, before the site is developed. We will have some personnel this summer for this particular thing. And we also propose building a branch museum of paleontology, and I'll explain that concept in a couple of minutes, interpreting strictly the paleontology of the Fruita Quarry tied in with the regional, with the local paleontology. This can also serve as a visitors' center, not at the site itself, not in the area itself, but out on the highway. The town of Fruita has, for a number of years, been talking to us about putting up a branch museum. Number one, they do want something like that in the area. We think it might be helpful to the public and to our own interests as well, of course, to have it limited strictly to paleontology. And it can also be a work area for Lance and so forth. One of the reasons for locating it on the highway rather than at the quarry is that in comparing it to, say, Dinosaur National Monument, where you have got a quarry area that also makes a good exhibit for visitors' center, this area does not lend itself to that particular type of interpretation. The area is rather large; there is more material than on just that hill. There will be, I'm sure, more things found. It's going to be scattered over a wide area and the material is not in the same type of -- oh, it doesn't create an exhibit type of thing, I don't think, if you understand what I mean.

MR. ERIKSEN: The bone isn't nearly as well preserved and . . .

MRS. GOODRICH: Any visitors' center might be better off away from the site; not jeopardizing the site, and perhaps not encouraging people to wander around tramping on small bones, small fossils, as they sometimes do. Briefly this is our proposal. I know the BLM is interested in having a visitors' center at the site. I don't know how it will turn out, but this is what the museum is trying to do. And we would like to cooperate in any way as far as creating a good area out here. I might add that in listening to

some of the comments, it seems to me that the implications that this area does have national and international significance really does require some sort of control of the area. Not haphazard -- just going in there and taking things out kind of thing. There should be some major attention given to the management of the area somehow.

MR. BENTON: Beverly, I think perhaps you're in a better position than some of us to worry a little bit about this. The county has never gone on record; we have been seeking constantly for the last five years the designation from 340 or from I-70 to the entrance to the monument as a scenic corridor to prevent industrialization and high density development. That would have some bad spin-offs in terms of preservation, and we have never gotten the commitment from the county that there are significant things in that area of various types, scenic and paleontological values. We have never gotten a commitment from the county that this has value, and I think, as you're probably aware, there's the constant battle there for major gravel crushing outfits. And I think the most recent one was a cement plant.

MRS. GOODRICH: I have heard plans for a major mobile home park.

MR. BENTON: There's a mobile home park right in the middle of that Morrison. In your role, you could advise the county commissioners to perhaps stabilize that situation a little bit, because we are not having all that great a luck.

MRS. GOODRICH: I think as a unit of county government, we also have a very important role to play as far as influencing them.

MR. BENTON: They aren't being influenced very heavily right now.

DR. ROBINSON: I think everybody agrees that the site is sufficiently exceptional and should be protected. I wonder what either yours, as the Historical Museum, or what the BLM's feeling is about erecting a branch museum or a visitors' center, at this time, when the country is gasoline oriented when we may be placing an additional tax of twenty-five cents per gallon and possibly more.

MRS. GOODRICH: Part of the reasoning for a site along the highway is because the monument does get over 600,000 visitors a year.

DR. ROBINSON: But will they continue to do so?

MRS. GOODRICH: Our attendance has been up the last two years.

MR. BENTON: I think it's pretty fair to say, Dr. Robinson, that the proximity to Grand Junction, even during the gasoline scare of a few years ago, caused our visitation to go up -- when every place else in the National Park Service in this part of the country went down.

DR. ROBINSON: Is that local rather than transient visitors?

MR. BENTON: I think it was a question of both. We saw a definite increase that year in bus tours, as an example. The monument lends itself very well to mass transit as an alternative. That's one of the reasons why we are interested in what happens with this, because anything that happens that close to us is going to have some major implications on our interpretive program, and visitor flow, if you will. It's only about three miles off the interstate to the turnoff, or less than three miles, to where you actually turn off to this area. We don't see that gasoline rationing, or gasoline prices, will change our visitation. If anything, we think it will go up. We just look to see a little bit more use of the same transit.

MRS. GOODRICH: I might add that the museum's attendance did not suffer any. In fact, it was going up slightly during the gasoline scare. We did not expect that to happen.

Are there any other questions?

DR. KING: We'll probably see this afternoon, but how far is the site from Highway 340 -- in miles?

MR. CROUCH: The area is right here (indicating) and a half inch to a mile, 340 comes right here. We are about a lineal mile and a half, two miles on the road from 340. The entrance to the monument is this purple area right here. Fruita, Colorado is right here. There's a bridge over the river. You go up a hill slightly and you turn right to go to the quarry area; you go straight ahead and you'll come into the entrance to the National Monument.

MRS. GOODRICH: The new road will be right here (indicating). We were talking about something like right in here.

DR. CALLISON: There is a hill through which the road partially passes just after it crosses the river, and from which Rigg extracted, I think, an Apathosaurus. So 340 goes right through the Morrison and right through a hill that has had a rather significant specimen collected from it.

MR. BENTON: Yes. And also, as Beverly mentioned, one of our worries right now, and it really should be ours as part of that hill is on private land, I think, or maybe all of it. And one of the real dangers in there is a major subdivision, some 340 housing

units, a mobile home park, an AB park, a motel, and a campground, all sitting in essentially the area that I assume has some potential value for paleontology.

MRS. GOODRICH: There are bones visible from the highway.

MR. ERIKSEN: Yes, there's a radius of -- in a rock that fell down off where Rigg's collected at. He mentioned that he never had found any dinosaurs in there. There weren't any, you know, it was in the brushy area.

DR. RIPPETEAU: To what extent would this proposed visitors' center, wherever it's located, be a research center or a curation center, or would it be largely exhibitory?

MRS. GOODRICH: We were thinking more in terms of an exhibitory center. That would depend on whether or not the Bureau of Land Management went ahead with something at the site. It could be both if it ended up being the only facility.

DR. RIPPETEAU: In this area or locality, how many other localities might there be in a fifty mile radius that might bear upon such a visitors' center yet to be discovered? You know, in the next 25 years.

MR. CROUCH: We have a number of well-known outcrops easily within 50 miles. Mr. Eriksen has located a number in both south and north Rabbit Valley. We have, apparently, a very rich quarry in Cactus Park adjacent to Unaweep Canyon. In addition, there's a number of small hills near this immediate area which have proven to be very significant. The area is extremely wealthy.

DR. RIPPETEAU: It would seem very important to make an exhibitors' center that goes beyond, perhaps, one quarry.

MR. ERIKSEN: There's some better fossilized bone, really, in Rabbit Valley and on into Utah.

DR. RIPPETEAU: If you take a 50-mile radius and include a lot of other formations other than the Morrison, it must include other fossils.

MRS. GOODRICH: I think the area, the pos ible location, that we are talking about is the most accessible. It's on the beaten track. Many people would have reason for going there, anyway. For that reason, it would serve the public's needs.

VOICE: Perhaps a couple of our gentlemen could respond to this question: What is going to be the long range scientific interest in this site? Is there going to be a situation where fifteen years from now maybe there won't be a visitors' center constructed, but the scientific interest will be moved elsewhere? Or is this something that we are talking about of long range?

MR. ERIKSEN: I don't see that, because there's a lot of bone right now out there. But there's just so much material in Rabbit Valley, as I mentioned before, and on into Utah that it's going to take almost forever to look at it.

VOICE: I mean this particular area.

MR. ERIKSEN: You have an area to go out from. That's a good area to start with.

MRS. GOODRICH: I don't think it's going to be played out, worked out, by that time.

MR. ERIKSEN: Well, there is, you know, a lot of dinosaur bone in that sandstone. It just depends on what we are allowed to collect it.

DR. ROBINSON: If you have to wait fifteen years, which I think is a long time for a visitors' center, is the bone still going to be in that hill? Will it not be collected by the people who really are involved in it scientifically?

MRS. GOODRICH: We want to initiate the museum's building program by 1981. And if we can work in a visitor's center, if this turns out to be the way to go, it would probably come immediately after the new building.

DR. ROBINSIN: 1981 is four years from now. What's happening to the bone in the four years?

MR. ERIKSEN: It's eroding away and you have some vandalism.

CHAIRMAN: I don't know how specific you gentlemen wish to get, but of course I'm hoping that you'll make some recommendations to us on protection of the site, both interim and after some kind of a facility is built. You have dealt with this kind of thing in other areas, perhaps vandalism protection and so on, but somehow I hope you'll address that to us.

MRS. GOODRICH: He brought up a very good point. Something needs to be done now and not wait.

DR. ROBINSON: I see various . . .

MRS. GOODRICH: This deals with things a little bit later.

MR. CROUCH: At this time, I would like to introduce Dr. George Gaylord Simpson, who's going to speak with us.

Dr. Simpson.

DR. SIMPSON: When this meeting was being planned, I wasn't sure I could come to it and therefore I was not initially put on the program. I hope I'm not going to throw off the timing by speaking now, but I did manage to get here. I'm very pleased, of course, that I could.

One of my primary interests for many years, for all my professional life, in fact, has been in the history of mammals, and including especially the early history. Two-thirds of the history of mammals was already over when the age of mammals started. We know far less about any part of that two-thirds than we do about any part of the one-third that followed. So that Mesozoic mammals, those that lived during the first two-thirds of the history of mammals, are usually precious. And the late Jurassic happens to be one of the particularly crucial times in the history of mammals, too. What we commonly consent to call mammals first appeared in the late Triassic. Through the Jurassic they were evolving and had evolved into a number of different groups, so that by the late Jurassic there are quite a lot of fairly fundamentally distinct kinds of mammals. But just one of these was beginning to separate out as being the one that was going to give rise to more than 99 percent of the mammals that live today, including ourselves. So this is a really crucial time. We don't know very much about late Jurassic mammals. There are some times in the Mesozoic that we don't know anything about mammals; in the late Jurassic we are lucky in having a little knowledge. I'll just quickly run over the whole world as to what we know anywhere in the world about late Jurassic mammals.

In England they are known from a single locality, which I mentioned in the remarks fairly earlier on, a locality in southern England. And for Mesozoic mammals that's a pretty good locality. Quite a few specimens have come from there; it's the locality on the Isle of Purbeck. And also a number of other small vertebrates associated with the mammals there are equally interesting, for their own sake, even though I think of them primarily as associates of mammals having come from there. In Portugal, three localities or areas -- these are called localities rather than areas -- have been yielding some late Jurassic mammals, but only one of these has yielded a reasonably good fauna. That is quite good, but it's only partly described as yet. The other two in Portugal are not particularly important as yet. In Africa many years ago, one single specimen, a measly little lower jaw without any teeth at all in it, was found, and that's absolutely all we know about any Jurassic mammals from the entire continent of Africa. From the entire continent of Asia we don't know a single Jurassic mammal, in early, middle or late Jurassic. From the continent of South America there are some early tracks that may be mammalian or may not. If they are mammalian we can't identify them more exactly than that. So you might say nothing important is known about Jurassic mammals in South America. The only late Jurassic, or for that matter any Jurassic, localities for mammals are here in the United States for the entire continent

of North America, as has been mentioned before several times. The classic locality is at Como Bluff in Wyoming, and there all but, as far as I know, two specimens came from a single quarry, the very famous Quarry Nine, which was discovered for parties working for Professor Marsh of Yale University. Some further collecting has been done at Quarry Nine, and actually did turn up one or two new things, but the results of the most recent collecting haven't yet been described. And then there is the Garden Park locality, as has been mentioned several times -- well, only three specimens of mammals, to my knowledge, have come from Garden Park. One of those was of a genus different from any of the much more numerous mammals from Como Bluff. That indicates the advantage of having mammals of that age from as many different localities as possible. Now, here we have a new locality where we know that late Jurassic mammals occur. At present the pickings are pretty slim. If I understood correctly from Dr. Callison, there are just three fragments of lower jaws and just one contains an imperfect and not very characteristic tooth. However, these all came from a fairly small surface locality and they were found by surface prospecting. This is a very good indication for the presence of mammals in that same bed, if the bed is dug into and I would say, dug out, so that I'm very sanguine about the possibility. Every time you follow up a prospect like this you're gambling, but here I'd say you're gambling with the odds greatly in your favor. In fact, if enough work is done here and it's done in the proper way, as I'm sure Dr. Callison and his associates would do it, the chances are, I think, almost sure that you're going to find good identifiable late Jurassic mammals. And the chances are that they certainly will add very significantly to our knowledge of mammals at this time. Also they will be fitting into a small vertebrate fauna as associates, which will be of the greatest interest as a community, as an ecological unit. Thus one can hardly exaggerate the interest of this. It has an interest which is really world-wide and in many different respects. For instance, from the point of view of paleobiogeography. What was the biogeographic relationship between the different parts of the world? And this fits in with the very exciting and indeed revolutionary movement in geology, the theory of paleotectonics. I mentioned the fact that quite possibly North America and Europe were a single continent in the Jurassic and later drifted apart. It's fairly certain that this is the case. Mammals will cast a good deal of light on that. Already the Quarry Nine fauna and the Purbeck fauna have cast some light on it. There is some resemblance, just as there are some differences, in those two late Jurassic faunas. There are at least three genera in common; that's quite a lot for two separate localities on two different continents with no land connection between them at present. I have already made the point that anything we find here is almost sure to add to our knowledge of a very crucial part of the evolution of mammals and to the evolution of our own very remote ancestors, but still ancestors. Now as to what to do about this, what I would recommend would be to go in on this bed on the surface of which the mammals were found (the three specimens

that are known now) as far as possible, to dig out that entire bed and work through it. Since the presence of some associated material is established, one should, of course, keep an eye out for associated material. The chances of finding associated material or articulated material of mammals, I think at any locality, is very small at this time. In fact, not a single piece of articulated material has turned up in any Jurassic locality as yet. If it turned up here, that of course would be marvelous. But I think the chances are against it, and there are some very good reasons, because most of these mammalian concentrations seem to be of mammals that have been eaten, oddly enough, and their bones have come apart and their teeth have come out of the jaw. I think this layer should be dug out on a large scale as rapidly as possible and as soon as possible. In doing that you'll keep an eye out for articulated material and you would treat that a little differently. But I think that every piece of matrix, every piece of the layer that comes out, should be screen washed, which is the modern technique for getting microfossils, microvertebrates, and that is where you are going to find mammal jaws and mammal teeth. It has the disadvantage that you can lose associations. You can, for instance, find a jaw coming out in two pieces and it doesn't stay together. It may have just a crack; it won't stay together with screen washing. But with care you can get those back together. They have recently been doing some very extensive screen washing in an earlier Jurassic bed in England. Only a very small part has been published, but I do know about the work. They have found there that it pays to take the matrix out in rather small lots and to mark and wash each lot separately. They do find that although they are getting single teeth, they get some association. They almost certainly find, in a single lot, more than one tooth that came from the same animal. This now isn't often done with extensive screen washing, but it should be done in a situation like this. This is already a discovery of importance. It is one that should be followed up as rapidly as possible. And I have made at least a slight suggestion as to how to follow it up.

Thanks.

CHAIRMAN: Dr. Simpson, you touched on something that I'm very interested in from the standpoint of the management of the site, and that is the rate of excavation. Now, I can understand the importance of getting the surface material gathered rather quickly because they'll deteriorate from weathering and what have you, but how quickly would you recommend that the material that's in the hill itself be excavated? I have heard archaeologists say, "Well, you know, we should go at this rather cautiously because 200 years from now they'll be able to interpret these things better than we can now." Did I understand you to say we should go in there pretty rapidly and get that material out?

DR. SIMPSON: As much of it as possible. I would say, yes.

MR. ERIKSEN: Yes, because 200 years from now some of that material might weather out and be gone.

DR. SIMPSON: With our modern techniques, I don't see how we are going to miss very much. Before this screening technique came up, yes, you could miss an awful lot. But if this is really done carefully, the way it is done now and usually practiced, I don't think you're going to miss much.

DR. ROBINSON: I just wanted to make a comment. There's a basic difference between the archaeological sites and paleontological sites.

DR. CALLISON: If I might add just another short comment. The degree to which the outcrop is already weathered I think would be one of the factors that needs to be taken into consideration. In over much of the extent of the productive horizon out on that ridge, the weathering has already reached the productive layer. And if we are to delay this, say, ten, fifteen, twenty years, I think even more destruction of the specimen is likely to occur. And for that reason alone, I think we should proceed as rapidly as possible.

DR. SIMPSON: Weathering will just go on, be moving right on through the years, so the sooner the better.

CHAIRMAN: That would be helpful if you gentlemen would address that in your report to us, because that's something I have been very interested in, as to how closely we should watch that rate of excavation.

DR. SIMPSON: And so far as we yet know, it's a rather small area that's involved, as far as getting the necessary mammals is concerned.

DR. CALLISON: And there's not much overburden.

MR. ERIKSEN: What I wonder here, if this dinosaur layer which is mainly sandstone, if that's on the same layer as what these small vertebrates are, then what should I do? Should I save every bit of the matrix and wash that out and see what's coming out of that?

DR. SIMPSON: I'm not sure your sandstone matrix is going to wash, but it may possibly. It isn't as promising as the rest. Obviously you should keep a close eye every time you take off some sand, be sure there isn't some little bone or some little tooth there. It would be a matter of experimenting. You can wash matrix with other liquids than water. Sometimes other liquids, like kerosene, for example, will work better. You'll have to find out whether your particular matrix in your dinosaur bed is going to wash properly

MR. BENTON: Dr. Simpson, it seems that they are working

two different problems here, or a number of different eras. It would seem that it would almost require a single coordinating body, or a single coordinating organization, whether it be government or scientific in nature, to wade through this particular area so that one value is not lost in searching for another. Would you agree with that?

DR. SIMPSON: Yes, except I would say, after all, this refers primarily to paleontology. Although there are two different kinds of paleontology going on here, it is not disconnected. It is all part of one thing, and those big dinosaurs were in the same fauna, presumably, as some of the little mammals. We don't want to lose sight of the fact that this is a complex community, and that while the techniques are going to have to be a little bit different, working for big dinosaurs and, say, working for some small reptiles (there could be some small dinosaurs, perhaps) and mammals. Their direct association is part of the single problem; in spite of different techniques and somewhat different approaches, it's all vertebrate paleontology.

MR. BENTON: It would be very difficult; if you had a particular interest, you could lose, if it wasn't very carefully coordinated by some group or some people, relatively small, it would be easy to lose, would it not, some values in searching for others?

DR. SIMPSON: Oh, yes. I think there should be an overall control there. There should be some central control, some one person that's responsible for the whole thing. But you are going to be using somewhat different techniques on different parts of the problem. That comes up in any broad scientific problem, of course, that you don't do everything in the same way even though it's one problem. You don't use a single technique all the way through.

MR. CROUCH: We are very fortunate to have a number of persons with us that are involved with quarry management, and the next speaker is Mr. Bob Barry from the Utah BLM office. He deals directly with the Cleveland-Lloyd Quarry.

MR. BARRY: What I intend to do this morning is to use something of a management case study approach, taking the Cleveland-Lloyd Dinosaur Quarry as an example case in the management of a paleontological area. In approximation of the normal case study format, I'll being by briefly describing the area and its uses. Then I'll back up a little bit and focus on the management history of the quarry, and finally I'll focus on three or four management issues which may be of particular interest to this conference.

The Cleveland-Lloyd Dinosaur Quarry, a mass burial site of late Jurassic dinosaurs in the Brushy Basin member of the Morrison Formation, has yielded a collection of somewhere in the

vicinity of 12,000 bones as a result of excavation efforts spread out over a period of about 50 years. Personnel from the University of Utah conducted the first legitimate excavations at the site during the late 20's. Then during the summers of 1939 to '41, Princeton University carried out major excavations and obtained sufficient material to mount a skeleton of an Allosaurus for exhibition at Princeton. The next major period of activity occurred between 1960 and 1965. During that time the University of Utah Cooperative Dinosaur Project, under the direction of Dr. William Lee Stokes, recovered nearly 8,000 bones pertaining to at least twelve genera of dinosaurs. Approximately a hundred individuals are represented in this collection, about 65 percent of them Allosaurus. Almost half of the materials obtained in the Cooperative Dinosaur Project excavation efforts have gone to displays distributed throughout the United States, Canada, several countries of Europe, and Japan. The remainder of the collection material forms the vertebrate paleontology collection at the University of Utah. Since the close of the intensive effort involved with the Cooperative Dinosaur Project University of Utah excavation efforts have been limited to very brief periods of operation over three or four field seasons. (Brigham Young University and the College of Eastern Utah have done some work in this vicinity, but they were not working out of the same quarry site.) The quarry site itself is located about 30 road miles south of Price, Utah. It's about 12 miles by gravelled county road from the nearest small community, Cleveland, Utah. (This remoteness is one factor that may distinguish the Cleveland-Lloyd site from the Fruita site, at least in terms of possible recreational use.) The officially designated quarry management area of about 80 acres is located on a bench between a major drainage and a higher plateau. The actual quarry working area is the toe of the slope leading up to the higher plateau. Facility development at the quarry includes the visitor center, protective shelters over the quarry pit, a small picnic site, and fencing. The visitor center is a simple wood and stone structure which fits quite well into the natural setting. The main display at the center is a cast of an Allosaurus. Other displays deal with dinosaurs in general and with the process of quarrying them at the Cleveland-Lloyd site. A few samples of the bone obtained from the site also are on display. When closed, the visitor center is protected from vandalism by simple plywood shutters. They are not anything that would stand up to a determined forced entry effort, but they have served to protect the visitors' center from vandalism over a period of several years. The quarry protective shelters, which are surplus Butler Buildings, were erected last fall over the area of present excavation interest. Until these structures were put into place, it was necessary to back fill the quarry pit at the termination of each field season. These shelters should eliminate that necessity. At any given time, one of these structures will be used as an excavation area and visitor viewing area. The other will be used as a storage facility and field laboratory. The shelters are so constructed that they can be moved fairly easily as excavation progresses. The picnic site at the quarry is a very small thing,

three or four units. It doesn't in any way compete with the scientific focus of the site, but it does nicely compliment the experience of visitors that come to the quarry. One other aspect of facility development that's probably worth mentioning is the fencing of the site. This fencing has substantially helped to reduce or eliminate vandalism problems. The fence is at least a quarter of a mile from any of the facilities, which in itself is a protective feature. The entry gate is so located that from the gate one does not see the facilities or the quarry pit area, and the gate itself is fabricated out of a four inch steel pipe. It thoroughly discourages any attempts to force entry.

CHAIRMAN: What kind of a fence was it?

MR. BARRY: The fence itself is a barbed wire fence.

As already indicated, the scientific use of the quarry has been fairly limited over the last several years. Recreation use during this period has remained fairly steady or is possibly beginning to decline. Use averages about 4,000 visitors per year. Approximately forty percent of these visitors are local residents. Another forty percent come from non-local areas of the state of Utah, and about twenty percent come from out of the state. Generally, the out-of-state visitors are either brought to the site by someone from the local area or they have a particularly high interest in dinosaurs and dinosaur quarry operation. Because of the low level of scientific use and activity during the last several years and because of the necessity to backfill the quarry pit each year, the quality of the recreational experience at the quarry has been severely diminished. Except for the visitor center, there really hasn't been all that much for visitors to see at the site. The situation has been salvaged, in part, by some very good work by the temporary recreational aides that man the quarry each summer. Hopefully, it will be possible this year to expose a small in-situ display that would greatly enhance the recreation experience at the quarry.

Current use and management of the quarry is a reflection, to a substantial extent, of past management activity and planning decisions. Any review of the past management history, of course, involves a certain amount of interpretation. One convenient way to interpret Cleveland-Lloyd management history is to view it as having evolved through three stages: (1) token management, (2) reactive management, and (3) planned management. The token management stage lasted up to 1964 and covered the period of greatest interest in the quarry on the part of the scientific community. During this period Antiquity permit issuance was strictly a formality. There is nothing in the records to even indicate that the BLM Price District was consulted in the process of issuing those permits, although they may have been. The materials that are on file indicate very strongly that the University of Utah came to view the Cleveland-Lloyd Quarry as their quarry during this period

of time. However, the University's activity at the quarry caused the Price Chamber of Commerce to become interested in developing the site as a tourist attraction. The Chamber prompted Representative Burton to propose a bill in Congress which would have made the quarry a national monument. The proposal went nowhere in Congress, but it stirred up additional interest in the quarry and greatly concerned the personnel associated with the Cooperative Dinosaur Project at the University of Utah. The University responded to Burton's proposal by asking Senator Moss to help them obtain ownership of the Cleveland-Lloyd Quarry site. That request ushered in the reactive management phase at the Cleveland-Lloyd Quarry. When Senator Moss' inquiry for the University of Utah reached Utah BLM, the response was that transfer of ownership might be very appropriate, but that before that could be accomplished the site would have to be studied by the National Park Service for possible inclusion in the National Park System. The Park Service study in June, 1965, identified the primary value of the Quarry as being the excavation of fossils for scientific study, but it also indicated that the full potential of the resource could only be achieved by providing public access and an effective, interpretive program. The report concluded that, given the existence of Dinosaur National Monument, the Cleveland-Lloyd Quarry did not warrant inclusion in the National Park System, but it went on to recommend that the site could be developed as a state park. As a result of that recommendation in the Park Service's report, the site was offered to the Utah Commission of Parks and Recreation for possible inclusion in the state park system. However, at about the same time, the BLM district manager became very interested in the quarry. A BLM management proposal was drafted, and support for this proposal was actively solicited from the local county commissioners, Chamber of Commerce, and the Carbon County Museum Board. As it turned out, the State Park Commission declined to accept management responsibility for the quarry, so the BLM management proposal essentially won by default.

This management proposal was very much a matter of expediency. In response to local interest, it focused on developing the quarry as a tourism attraction, but no consideration at all was given to the possibility of conflicts between scientific and recreational use. The proposal also was oriented very strongly toward facility development. This orientation essentially reflected the fact that the Castle Valley Job Corps, operating in the area and at that time, was looking for projects that they could construct. The question of how facilities at the quarry, once constructed, would be operated was almost totally ignored in the management proposal. In short, the proposal reacted to external suggestions from the Park Service, pressures from local tourism boosters, and opportunities in the form of the job corps. It really gave no consideration to management objectives or to the long run implications of the proposed management actions. This reactive, opportunistic management was the rule for several years. In 1968 lands in the District were being classified under the Classification and Multiple

Use Act, so the quarry lands were withdrawn from entry under the mining laws. In 1975 the University of Utah donated a portion of the funds needed to construct the long needed protective shelters, so the BLM finally obtained funding to actually get those structures in place.

Finally, in 1976, time was programmed in the annual work plan to prepare a management plan for the quarry. The management plan was prepared about a year ago, and with its completion the period of planned management action at the quarry, hopefully, has begun. Obviously, opportunities to advance quarry management are not going to be ignored simply because they are not in the plan. Now, however, there is a yardstick by which opportunities can be evaluated, and having a plan that identifies what should be done at the Quarry is facilitating the programing and funding of the identified needs.

In the management plan, three broad management objectives were identified. The first of these objectives is:

To protect the scientific value of the Cleveland-Lloyd deposit and to provide for its utilization for scientific research and collection of paleontological specimens by qualified professionals.

A statement elaborating on this objective emphasizes that protection of the scientific value of the quarry is deemed to be the priority management consideration. In situations where matters relating to protection or scientific utilization of the quarry conflict with recreational or educational use, the scientific values will be given priority consideration. However, this does not mean that the convenience of the scientific users will be given priority over over recreational or educational use. The second objective identified in the management plan is:

To provide the opportunity for public enjoyment of the Cleveland-Lloyd resource with emphasis on providing an intimate, quality experience focused on the unique values of the Cleveland-Lloyd Quarry.

Note that this is not a "tourist attraction" type of objective. The ideal recreation experience under this objective would be for the visitor to be able to closely observe excavation work in progress and to interact with the interpreter at the visitors' center or with excavators, if and when they are working. In accordance with this objective, the formal interpretive effort at the quarry will focus exclusively on the paleontological values. Unrelated or conflicting uses of the site will be discouraged or totally prohibited. The third management objective identified in the plan is:

To provide an environmental educational experience for school

and similar groups focused on the Cleveland-Lloyd paleontological resource.

The educational experience to be provided at the quarry is very similar to the recreational experience. The focus will be on paleontological values and groups seeking only general "nature study" type experiences will be guided to other locations in the vicinity.

A number of management actions intended to implement these three objectives are identified in the plan. Some of these actions can be mentioned briefly for illustration. In the plan, the rationale and means of implementation for each action is identified. I'll simply run through a few of these briefly.

The first identified action is to review the adequacy of the present designated boundaries of the quarry. There is very definite uranium prospecting interest in the immediate vicinity and the west boundary of the withdrawn quarry area runs only 200 feet from the present quarry pit. A second action is to upgrade administration of antiquities, permits for scientific utilization of the quarry. A third action calls for redefining the existing relationship with the University of Utah. A fourth action is to encourage active scientific utilization of the quarry deposit. (There is a potential "conflict of interest" for the BLM inherent in this action. Strictly speaking, the BLM role in scientific utilization is fulfilled by protecting the resource and facilitating its use by qualified institutions. So long as the resource is protected and available for research use, the management objectives relating to scientific value are achieved even if no use occurs. The management objectives which are not met when scientific work is not in progress at the Quarry are recreational and educational. When excavation work is not taking place, visitors miss the ideal experience of seeing the Quarry in operation. The BLM, thus, does have an interest in seeing active utilization of the scientific resource take place. But, this interest in scientific activity is based on "ulterior" recreational motives. Clearly, it would not be in order for the recreational objective.)

A fifth identified action that badly needs to be accomplished is to develop and implement an interpretive master plan for the quarry. Finally, an action is identified to encourage educational institutions of the availability of the quarry and by developing an educational package. These actions, along with others that are in the plan or that could be added to the plan under the umbrella to the identified objectives, should move management towards resolution of some of the major management issues and problems that have not been dealt with successfully up to this time.

Several of the management issues and problems at Cleveland-Lloyd clearly are not site specific. (A lot of the things that have

been mentioned here this morning almost sound like pages from the files on the Cleveland-Lloyd Quarry.) There are at least three issues that would seem to be particularly likely to surface at other areas such as Fruita. Undoubtedly, these issues will not be new to most of this group, but perhaps the perspective coming out of the Cleveland-Lloyd experience will be useful.

The first of these issues relates to the question of whether or not, or to what extent, scientific use of a resource by an institution creates a future interest for that institution in the use or management of the resource. Antiquities regulations, of course, prohibit the granting of exclusive right to collect at a site. Still, there are some very real pressures toward dominant if not exclusive use. Strictly from the point of view of the managing agency, the use by a single institution greatly simplifies management of the site. With only one using institution, there's a ready resource of technical input, there is no problem with conflicting applications, and the collection and related information tend to be available under one roof. At Cleveland-Lloyd a de facto exclusive use situation has prevailed for almost the entire history of the quarry, yet this particular management issue has been a major factor in Cleveland-Lloyd management. As previously mentioned, when BLM first began to show some signs of life in attempting to manage the quarry, the University of Utah responded by attempting to obtain ownership of the quarry site (which would be the ultimate in having an exclusive use permit). Then in 1966 the Utah BLM State Director went on record stating that while the University could not be given exclusive rights to the Cleveland-Lloyd Quarry, they would be given "first preference" and would be consulted before issuance of a permit to other institutions. This policy was reinforced by a letter of agreement between the BLM and the University in 1969. Apparently the University didn't feel that its interests were adequately protected. In 1970 they asked the Smithsonian Institution for assistance in obtaining exclusive rights to do excavation work and collection at the quarry. That approach got nowhere, but in 1975 the University tried again to obtain a guarantee of exclusive use. The University's contribution toward the construction of protective shelters for the quarry was accompanied by a proposed letter of agreement which would have given the University exclusive right to collect at the quarry and also would have made all material collected from the quarry part of the paleontology collection of the University. There were some special conditions present at Cleveland-Lloyd which contributed to this problem issue. The fact that the University was well established at the quarry before the BLM began to take an interest in managing the site was certainly one factor. Another factor may have been the initial emphasis in BLM management on developing the site as a tourist attraction. Still, the Cleveland-Lloyd experience seems to suggest a definite need for the managing agency to carefully define policy with respect to this issue, to do so at the earliest possible point in time, and to implement that

policy through a formal mechanism for communicating it to using institutions.

A second highly related issue of management that has been very much with us at Cleveland-Lloyd involves the question of how deeply involved should BLM become in trying to manage scientific use. A number of specific questions come under the umbrella of this issue. Are permits going to be issued on demand to qualified institutions? If not, how will permit applications be evaluated and who in the agency will have the skills to perform evaluations? If there's a possibility that conflicting applications may be received, how will conflicts be resolved and what priorities will be established? What special stipulations, if any, will be needed to protect resource values, and how will those stipulations be administered? Is there a need for an information depository to facilitate scientific use of the area? If so, what information will be included? Who will manage the depository and what mechanisms will be used to insure that the necessary information is submitted and that the material submitted meets quality standards? Finally, should these be a BLM effort to manage the preservation of the collection? If so, what mechanism should be developed for carrying out such management? All of these questions relate to potential management actions that are suggested by, or consistent with, antiquities regulations, and they very much have been questions involved in Cleveland-Lloyd management.

The answers to these questions must be framed in terms of what is needed at a particular site to most effectively protect the resource and to facilitate its use. At Cleveland-Lloyd right now the BLM is in a very awkward situation. Permits for use of the Cleveland-Lloyd have been issued uncritically on demand. Preliminary reports providing virtually no useful information have been accepted and the required catalogs of collections, if submitted at all, have been in the form of rough field notes. On the matter of disposition of collections, the BLM District, at least, has no record whatsoever to indicate that the required written authorization from the secretary of the Smithsonian has been obtained prior to transfer of parts of the collection. In short, it would be almost impossible for the BLM to facilitate scientific uses of the Cleveland-Lloyd Quarry or even to provide information regarding past use to institutions wanting to use the area or to other scientists seeking information about it. The Moab District is beginning to correct this situation. Requests have been sent to the University for specific information regarding past excavation efforts and findings. Requests for records will be sent to the Departmental Consulting Archaeologist and the Smithsonian. The District has also recommended that a permit not be issued this year until a definitive statement of research objectives and work to be accomplished is provided. If a permit is issued, a token report and rough field note catalog of collections will not be deemed acceptable as a report under the permit. Once these elementary steps are accomplished, one mechanism or another will be used to

obtain professional input to develop long range procedures for quality management of scientific use.

A third management issue that cannot be considered separately from that of scientific use is the issue of recreation management. If there is the remotest possibility that a scientific resource is to serve recreational purposes, then both types of use should be planned for concurrently. Otherwise there is the strong possibility that neither the recreation nor the scientific value of a site will be efficiently utilized. At Cleveland-Lloyd, the decision made during the late 1960s to construct a visitors' center rather than protective shelters provides an example of this point. That decision was based strictly on recreation considerations. Had both scientific and recreation use been considered, the obvious choice would have been to build protective shelters over the quarry pit immediately and delay construction of the visitor center if necessary. With shelters in place, it would have been possible to remove the backfill from the quarry pit, thus facilitating scientific use and greatly improving the recreational experience at the quarry.

In considering the recreational potential of a paleontological site, there are again a number of questions to be asked. First of all, does the site lend itself to recreation use? Will the anticipated nature, duration, and pattern of scientific use compliment recreation use? Can recreation use be made without having a detrimental impact on scientific use? What kind of recreation experience is to be provided? How does that experience fit into the existing supply of recreation opportunities in the region? Will that experience be consistent with the interests of visitors who will be drawn to the site? Only after these basic questions have been examined does it really make much sense to start thinking about visitors' centers, interpretive personnel and so forth. All too frequently, however, these basic questions are not examined and the result is some very suboptimal recreation management. At Cleveland-Lloyd these questions were not even raised, and the recreation experience has not been what it could have been over the last several years as a result. The impacts of not asking those questions several years ago are even going to continue into the future because the options available for consideration in the recently prepared management plan were very definitely constrained by the decisions made in the past.

It would be possible to go on almost indefinitely on issues that have been raised by the Cleveland-Lloyd Quarry experience. Vandalism protection would be one possible issue; manpower needs for this type of management operation would be another. However, I think I have probably talked long enough, so I'll close with the observation that the Cleveland-Lloyd situation has been very definitely a matter of starting too late and then moving with too little in the way of sound planning. Most of the actions in the recent management plan are really remedial actions designed to try

and make up for this history of too little too late. I frankly envy the Grand Junction District their being in a position to get something going in management of the Fruita site concurrently with the scientific interest. But, I cannot over emphasize the need for careful planning as the Grand Junction District begins to manage the Fruita site. If there's a possibility of recreation use being made at Fruita, it must be planned for now, not later. Questions like the probable duration of scientific activity versus the useful life of a visitors' center simply must be examined carefully and quickly so that management can start off on a solid footing.

MR. BENTON: I would just like to echo your concerns on the need for dual planning. At this stage I think the National Park Service has probably had a higher level of protection ability, whether we have utilized it or not, toward some of the scientific wealth that we have in the management part of it. I would urge you all to heed our mistakes. As rapidly as the paleontological value, or archaeological values or historical values are publicized to the community of the Grand Valley they are destroyed. Just as quickly as something is surfaced -- we go back to the 30s era of the major fossil finds in the Morrison formation towards the top of the Park -- as rapidly as those discoveries were made, they were vandalized, and apparently some very significant finds were totally lost simply through publicity. We tried to do some publicity as recently as one year ago on some of the prehistoric sites and measurable amounts of deterioration, including substantial vandalism, that has occurred within the last twelve months simply through the form of overt community publicity. And I urge you to be very, very careful of this site for the very reasons that you stated. Publicity is good to the point where it solicits support, but it also has the danger of damaging what you're trying to get the support for.

MR. BARRY: The Cleveland-Lloyd publicity that accompanied the extensive activities during the early 60s was what really caused the push for tourism attraction development, the "we are going to out-Dinosaur Dinosaur and make more money off dinosaurs than Vernal does" attitude. That type of attitude just comes through tremendously in some of the materials on file. Then, as you say, the publicity of a site produces vandalism. The only way that we have more or less protected the site from vandalism over the long haul has been by keeping it buried. There was an attempt at one time to expose a small display with just a chain link fence around it, and the display walked off just amazingly.

DR. ROBINSON: A chain link fence draws attraction to it. This is one of the reasons that many members of the paleontological community have been reticent about making their localities of their finds known. Because if it gets into the public record, eventually it may surface. And so I just wanted to make that observation. I do know of cases where localities on BLM lands in northern Colorado were only desultorily brought to the attention of the proper authorities

because they were afraid if it really got into the record it would disappear.

MR. CROUCH: I share your concerns for this. This occurs frequently with our archaeological and historical sites, and we have made an attempt to keep the information concerning the Fruita quarry to a minimum as far as people knowing it. Of course, the area is well known because we do have vandals, but we hope to be able to provide as much protection as possible in the interim before a solid management plan is made. It's a constant problem that all cultural resources have, and it's very difficult to deal with.

MR. BARRY: One problem that we have as managers is sometimes this reticence of scientific users to let us know where sites are. I view it as a problem. If we don't know where a site is, and we are doing a management plan for a broad area, then that site doesn't get considered for protection. So yes, I'm sure there's some danger in reporting it to the authorities. I'm sure at times the authorities have overreacted, gone out and publicized it, but I hope we are getting a little more sophisticated than that at this point. We are learning to keep our traps shut.

MR. ERIKSEN: It sort of works both ways. I think about whether we should put a fence or a sign -- and the sign there tells innocent bone hunters, if there is such an animal, that they shouldn't be in there. And on the other hand, a fence provokes some people, too, that maybe wouldn't go in and wreck too much stuff, to really go in and wreck too much stuff. It works both ways.

MR. CROUCH: I think that we have experienced a decline in vandalism of this area since we installed the fence. I don't know, Lance, if you have recorded any recent, say, within the last few months, attempt to take anything. We had a dilemma and our decision was to place the fence there, and it seems to, at least at this point, have helped somewhat.

MR. ERIKSEN: I think it will slow it down. The spring will tell you. That's when they come out, you know, after the weather and that sort of thing.

MR. CROUCH: Thank you. Mr. Barry?

MR. BARRY: I do have some copies of the Cleveland-Lloyd Management Plan available for any of you that might want them.

MR. CROUCH: Thank you very much.

We have had a very informative morning.

Please enjoy your lunch. At 1:00 we will get back and go out to the quarry. I realize it's rather cold out there and I don't know if it's muddy, but if the circumstances are right perhaps some of the gentlemen can show us what they have been finding.

(WHEREUPON, the meeting was in recess at 12:15.)

(WHEREUPON, the meeting was reconvened on Tuesday, March 29 1977 at 9:00 AM)

CHAIRMAN: I guess we can proceed on with the program.

MR. CROUCH: Our next speaker is a gentleman that works in our area frequently. He's Dr. Peter Robinson from the University of Colorado.

DR. ROBINSON: My comments are going to be quite brief this morning. I feel like I have the prime qualifications of an expert. I have never seen the site before this particular meeting. It is difficult to propose specifics ahead of time about the Fruita dinosaur area, having not seen it until the time of this conference. However, I will endeavor to raise some generalities about fossils and their management, which hopefully can be applied to the case at hand.

Fossils have at least four values: to the amateur collector, who prizes his collection of curios; to the layman for purposes of education; to the scholar who uses them for research; and to the commercial collector who sells them to others.

The sale of fossils is not as common in the United States as overseas, but many of the fossils sold in Europe, for example, are collected in this country. And even the famous auction house of Sotheby's, London, has had auctions solely for fossils where they have brought handsome prices. Sometimes the values listed above overlap, and I, as a paleontologist, can claim to collect fossils for pay for my institution, as well as to use them for research purposes. However, we do not collect for resale.

The academic community can look upon fossils as their sole prerogative, forgetting the other uses listed above. However, the sad fact is that fossils kept in amateur collections or in poorly maintained public ones often deteriorate. Those sold as curios have no data with them and are, for the most part, scientifically worthless and lost to the world of research. However, the academic community is small in numbers and the educatable public is large indeed and must have access to scientific wonders, including fossils, for its own information and aesthetic enrichment.

The problem has been how to achieve both ends. Firstly, most fossil vertebrates are not complete enough to be useful to the average citizen. Although we have some 20,000 cataloged fossil vertebrates at Boulder, less than 20 skeletons and less than 75 skulls in our collection of higher vertebrates are complete enough to put on exhibit. Therefore, most of the available material for exhibits is fragmentary and difficult for the untrained eye to evaluate. The overwhelming bulk of fossil vertebrate specimens

are of research value only. On the other hand, the information that can be gained from a collection of fragmentary fossils properly studied is often large and significant in the interpretation of the evolution of animals in the reconstruction of the conditions in which they live and in the development of the paleogeographic synthesis. This information can then be made available to the public at large through books and even better interpretive displays. The academic community is therefore responsible for making such information available to those who wish to use it for the making of displays or for simply learning.

The managers of fossil resources have the obligation to evaluate the many variables about their resources, some of which are, what is the best utilization, both in terms of research and preservation. Who is most capable to do this, and an often overlooked criteria, where is the best place to house them and how should it be done? And where will the resources get the most efficient and especially economical utilization, if a decision is made to make most of the material available for research? Can the institution chosen to do this really support a research function in terms of trained personnel, facilities and especially libraries? Can the institution involved accept the cost of training paleontologists, train preparators, proper equipment and proper reference material? In some cases the initial cost just for personnel and equipment will be no less than $150,000.00. And the ongoing cost $50,000.00 to $75,000.00 a year. The facility costs would be additional, and one must ask is it wiser to create an entirely new facility or is it wiser to try to adapt an existing one?

If one decides to make the facility primarily a public oriented exhibition structure, can you justify it on the basis of population or, even more important, can you justify it in terms of energy, knowing that gasoline will probably be rationed or curtailed in some other fashion in just a few years? How many months of the year will the facility be in use to the general public if the weather is a factor? Suppose that one tried to combine the two choices of both. Where is the most effective place to carry it out? Can one have duplicating facilities of this type in the same general area? For example, the Denver Museum of Natural History maintains a large exhibit program, some of which is world renowned, and essentially no research program. In Boulder, the opposite is true, where we maintain a minimum of exhibits and an active research program. Even we, with 1,500,000 people in the metropolitan area, can not afford to compete with duplicate programs. How many fossil sites are worthy of an on-site display at some distance from population centers? One thinks of existing national monuments such as Dinosaur, Agate or Fossil Butte. How many areas should be simply restricted to public access for salvage by trained paleontologists at a slow pace and over a period of several years?

Another question which should be asked in management is,

are there areas which should be set aside for amateur collecting? One example of an area that might be so designated would be Toadstool Park in northwestern Nebraska. How are the fossils to be managed and by whom? If the Bureau of Land Management manages, for example, what commitment is there that adequately trained paleontologists will be in charge? Getting down to specifics, what percentage of the Fruita material is of display quality versus research quality? What commitment is the scientific community willing to give towards the present and future utilization of these materials? Decisions on technical scientific matters should be determined by the scientific community involved, whoever and whatever institution ends up with the management of materials. It is a massive obligation to the public and the scientific community, which is in perpetuity. Can the individual institution guarantee this? This morning I added this last statement because I was impressed by what I saw yesterday. In my opinion, the Bureau of Land Management's greatest contribution to paleontology in the Fruita area would be the continued isolation of the fossil bearing areas from the rock hounds, and the support of the scientific community in the extraction of fossils to allow their proper study at some later date. And exhibitions could be developed, preferably in Grand Junction, interpreting the fossils of the area.

Thank you.

CHAIRMAN: Pete, one item there kind of piqued my interest. I thought a little bit about whether or not some sort of an advisory council would be in order, made up of scientific people such as yourself and others, to advise the Bureau on the rate of excavation. Have you thought about anything like this, have you seen it done elsewhere, where a management of a site, I suppose, was done by one responsible agency?

DR. ROBINSON: I'm certain it must have occurred in this country. I don't know of examples. I do know of examples that occurred overseas where a committee, if you will, is in overall charge of a program. But there is an on-site supervisor who is in day-to-day charge, and I don't think this is a particularly difficult situation. I honestly don't think you have to go too far to get the people who are already involved in the program to do this. I have a dread of committees, but I think that between the people in Grand Junction and George Callison and so on, adequate scientific input is available.

CHAIRMAN: I was toying around with the idea, would it be appropriate, say, if you had some kind of an advisory committee that would meet once a year, look over what's been done and advise the Bureau? Or is it worthwhile? Would a single paleontologist in the Bureau assigned to this area be adequate to do something like that?

DR. ROBINSON: I don't know. I suppose a committee would

be all right. I wonder if you can justify hiring a paleontologist in the Bureau for this area? That's the question. As much as I would like to see it, that's not the point. It's a question of economics. Are there any other questions?

MR. CROUCH: In 1976, when I first became acquainted with Dr. George Callison and of course Mr. Lance Eriksen, and their works in the Fruita area, we at the district office here in Grand Junction became aware that the resources in that particular area, as well as the adjacent areas, were extremely significant. When George found his important mammals, and became very excited, we started taking a real close look at this area. Later we started receiving letters from many of Dr. Callison's colleagues, including Ferris Jenkins, Dr. Simpson, Dr. Clemens and Dr. Colbert. And all these letters pointed out the same thing, that we have got to take some action immediately to prevent this area from being vandalized. Our problem up to that time had been pointed out by Mr. Eriksen, that we had received large scale thefts and vandalism in the outcrops that we showed you yesterday. Also, we had to look at the area to see what kind of long term management quidelines we should initiate to insure proper management of this area. In 1976, after we received these letters and the information that Dr. Callison provided for us, we presented a management plan to the Denver office on how to manage this quarry based on the information that we had at that time. That information consisted of the letters that you gentlemen had provided for us as well as the management plan for the Cleveland-Lloyd Quarry, which the Utah BLM provided for us. The results of that proposal, in 1976, were primarily the funding for this meeting. It was thought that if we had the professional advice and recommendations from the persons most interested and most competent to make these decisions provided to us, that we would be able to make management policies that would be consistent with the significance of that area. So our first result was getting funding for you gentlemen, and today. Secondly, we provided patrols for the area. We knew it was being vandalized and we didn't have any funded patrols in recreation or archaeology for this service. But we did have a branch that had manpower that we could use. It was our operations branch, and we did use these gentlemen to provide protection for us. We feel that that did help. But there was some thefts occurring even at that time, so we made a recommendation that the area be fenced, primarily to keep out large vehicles. It was felt by Mr. Eriksen that the large vehicles allowed large equipment to be brought close to the quarry. Consequently they could remove large fossils. We did fence the area. The first week that we had the area fenced we went out there, and the locks were cut, so we got larger chains and since then we feel that this fence has deterred major thefts in the area. We also put signs in the area. Now, we have an opportunity to make management plans based on recommendations from you gentlemen, and in our proposal for management of this quarry this is our first step, to obtain the recommendations. Our second step is to continue with our program on deterring vandalism, and we plan to

continue with our program on deterring vandalism, and we plan to provide patrols for the area this year. We hope to make this a permanent program in the future. We propose to install sensors in the ground that would detect any large scale impact. These have been tried at California with some degree of success and we feel that this may be able to help us. We also plan to request that our staff be increased with a paleontologist. We feel that a paleontologist would not only be able to provide directions and synthesize your recommendations and our concerns for this area, but he would also be able to provide the needed expertise we need in general for this entire district. We have a tremendous amount of Morrison and Green River formation, and we feel that it would be in our best interest to have a paleontologist decision pertinent to paleontological resources. Also, we hope to work closely with the different institutions and their permits for this area, hoping to regulate the specialized interest in some manner that is beneficial to all. We would also like to propose that we establish a small committee, as Mr. Owen mentioned, composed of scientists and institutions that are interested in this area and interested in the removal of the resources that we have here. In addition, we have proposed to register this area in particular as a national landmark. We have also thought that it would be appropriate to reconstruct the small rock house out there as an interim building for housing, making available a facility for the patrol to stop at and to house any equipment or fossils that instutions working on the site would be removing at the immediate time. Once we get these initial proposals underway, we propose to build a research and visitors' center in that area, constructed to standards that would insure proper curatorial, research, and interpretive facilities. Also, we propose to staff this facility with a paleontologist as well as the needed staff for facility management. Our prime goals in working with paleontology in this resource are to maximize the use of the fossils and resources for the scientific community, make everything as easy as possible, maximize the use of this area for any potential recreation qualities that this area has in Fruita and the general region and manage these resources as prudently as possible. Any questions? Dr. Simpson?

DR. SIMPSON: I'm a little puzzled as to what your staff paleontologist here would do. Would he do any collecting himself? Would he do any research himself? Would he decide who's going to do the collecting and research?

MR. CROUCH: Our resource specialists at present have a defined parameter on their work. For instance, I'm an archaeologist and I'm more or less curator of the archaeological resources in our district. I provide guidance for the managers of BLM and also outside agencies on how they should work in relationship to our resources. At the same time, we do work with the resource itself. For instance, if a particular resource is in a position to where it may be damaged or destroyed, we will excavate it. We also try

to garner all the information associated with these resources and make it available to anybody that can utilize it. We don't, as a general rule, carry out hard core research projects. However, we do, of course, constantly add to the body of knowledge available for research, and we carry out small research projects. I would assume that a paleontologist would share these same functions. He would provide the needed expertise that we lack in the field of paleontology on the western slope. In addition, he would collect, I'm quite sure, those fossils that are in immediate danger of being eroded or destroyed in some manner. I would assume that this man or woman would also provide the link that we lack now for reviewing institution permits that deal primarily with paleontology. We don't have a paleontologist at present to review any of the antiquity permits of the institutions that deal in paleontology.

DR. SIMPSON: All fossils that are exposed now on the surface are in danger of deterioration or complete loss. This paleontologist would then, since apparently conservation would be among his duties, would it be his duty to see to it himself that he picked up all those and saw that all of those were picked up? And what would happen if someone, say, from the University of Colorado wanted to work in the area and the resident paleontologist felt that it was his job to do the prospecting, to find the surface specimens?

MR. CROUCH: The resident paleontologist's responsibilities would not supercede, for instance, University research designs. They would be of an immediate nature. If we had, for instance, an emergency as pointed out by the museum -- several months ago a small reptile, I believe, was being exposed and it was felt that one more freeze and rain would totally destroy that, therefore removal is mandated. This occurs with some frequency in this area. It would be these kinds of tasks that a resident paleontologist might perform. He would not, by any means, interfere with Dr. Robinson's project, for instance, in Rifle or any other area. He would work between the agencies. He would not be primarily concerned with research.

DR. SIMPSON: Where would the specimens that he collected go?

MR. CROUCH: At the present, we store most of our paleontological resources with the museum here in Grand Junction. We are building a new building near the airport that is going to have a small laboratory and some capability for storage and curatorial functions for resources of this nature. But primarily we store them with the museum. And I understand that the University of Colorado has some.

DR. SIMPSON: But there wouldn't be any research program going on continuously under present conditions here, as far as I can see.

MR. CROUCH: No, not by the Bureau. I wouldn't expect that this district would carry on an intense research project.

DR. ROBINSON: How can you justify economically adding another paleontologist in this area?

MR. CROUCH: Well, Mr. Matlock and I discussed this to some degree this morning. This wouldn't be an institution; it would be a facility to . . .

DR. ROBINSON: You would still have personnel, a paleontologist that works; you have already got one in Grand Junction. Considering the expenses involved, it seems to me it would be a lot better to contribute to the improvement of the existing facilities in Grand Junction rather than try to bring in a completed one.

MR. ERIKSEN: I would like to say something, too, here, about the marine reptile. There wasn't much left. Most of it had been washed and weathered away in the Mancos up here. What I would like to know, on some of these things it's a matter of really getting out there and getting it right out of there. Because if we had had a hard winter -- well, it took six weeks to get a permit, and if it would have snowed right away the rest of the flat bone would have been totally gone. What I would like to find out here is, is there any way on some of these surface collections like this that I could get some kind of a form or something that you could just fill out, send it in and go ahead? You know, and get this out of there, because it's a matter of time.

MR. CROUCH: I'll answer your question, then. Dr. Robinson's -- I wasn't aware, I thought it took about three days. We did it over teletype.

MR. ERIKSEN: It was six weeks, almost to the exact day.

MR. MATLOCK: Six weeks before you got your phone call, or before you got your papers?

MR. ERIKSEN: Before I was okayed to go ahead.

MR. MATLOCK: Under emergency conditions, it takes about three days.

MR. ERIKSEN: Actually, I really can't see in a situation like that where you would need anything. There was no digging; there was nothing. I just went up there, threw some plaster over it. But it took six weeks before that could happen.

MR. MATLOCK: Throughout the Interior, under the departmental consulting archaeologist, when issuing permits to paleontologists, one of the greatest voids has been that there have been

no paleontologists around to define the parameters and which permits should or should not be issued. In archaeology, where we have an emergency situation, we still issue a permit. The law stipulates that you're going to do that, and that's been simply interpolated onto paleontology. If you're on the ground in any way working with that resource, you should be under a permit to do so. There's never been any parameters established by paleontologists in terms of . . .

MR. ERIKSEN: It still comes back to the simple fact if it would have snowed on that, there wouldn't have been anything of this left.

MR. CROUCH: The permit system is changing. The Antiquities Act of 1906 is at present functioning with paleontology as one of its sciences, but it has been recommended that this be changed. And I understand it has been changed. But I don't know exactly how yet. Dr. Robinson, in answering your question, I think we have such an extensive amount of paleontology in this district that we could justify a paleontologist.

DR. ROBINSON: What would be the criteria that you would use in selecting the paleontologist? Do we have another BA who's wet behid the ears or do we have somebody who has some real experience?

MR. CROUCH: I'm not really sure. This is handled by our Denver service center. We ask for a specific type of person with a specific type of background.

CHAIRMAN: I'm anxious to get your thoughts about that. I'm not anxious to hire a paleontologist so we can brag about the fact that we have a paleontologist on the staff. Without understanding the field completely, I proceed on the notion that there are many areas in this two million acres that we administer here in western Colorado that have some potential for paleontological values, and I couldn't name the times in the past 50 years that various surface activities have been conducted with little or no recognition of any paleontological value that may have been destroyed. So I would anticipate one of the primary functions of the paleontologist, if we had one, would be to take a look at any areas proposed for disturbance where there was a possibility of having a paleontological value, and then adjusting the surface disturbance or not allowing it or modifying it. So we would hopefully not destroy anything. So it's in that general area I would think there may be some value from it. But I do value your opinions on this.

DR. LEWIS: Russ, in the Park Service, do we encounter this six week delay on such things as Lance described? I didn't think that we were handicapped to that extent. Isn't that delegated down pretty far, as far as emergency type situations?

MR. KING: I'm not sure, to tell you the truth. I have

only been with Dinosaur two years and I have not been involved in anything at the Monument itself. But I would guess that in the past, from SVP meetings and whatnot, that it has taken quite a period of time under the conditions that you mentioned and we have been speaking about. I think that's where the resident paleontologist at the Department of Interior level could provide some real assistance. And that given an emergency, we could go out and salvage what was there and do the job of collecting it without having to worry about paper work, without having to advertise.

MR. BENTON: I thought that's what we did at Badlands, South Dakota. Of course, you know, it's a constant problem there with virtually every rainstorm. Of course, South Dakota Tech is contracted to work that area. But I thought when they discovered something of magnitude there it was an instant thing. I mean, it was delegated down to a pretty low level. Cecil has never talked about that; he was at the Badlands for years.

MR. KING: He was at the Badlands and I was at the Badlands temporarily for a couple of summers, and I did do some collecting of materials which someone, a visitor, had reported. And they were going to weather out or be vandalized, so I went out and collected the material. And I think where the Park Service is perhaps different from the BLM is that in one very large sense, given the almost inexhaustible supply of oreodont material in the Badlands, or the Fossil Butte material, one of the responsibilities of the Park Service is to preserve the natural processes of weathering. So that in fact, in actually removing a less than significant specimen, if it can be determined as such, you are deterring the enjoyment of visitors present and in the future. So there's some grey area in there: should every specimen managed in an area by the Park Service be collected, or in fact, should some weather out; and is that not what the visitor is due to look at when they come to visit an area that has some paleontological things in it? Now, when we were talking about limited specimens such as a dinosaur where you have a finite number of bones in a very concentrated area, it's a different story. If you are talking about scrap material, there's scrap material weathering out on the east and west of the quarry that we really do not worry about collecting, because we don't as any paleontologist would know, you don't want every piece of scrap material collecting dust on a shelf.

MR. MATLOCK: Also, if you have somebody under contract to you they don't need a permit from the agency.

DR. KING: I think the Badlands is something special in terms of the South Dakota School of Mines being so close.

MR. BENTON: It would just seem to me that they're constantly down there.

DR. ROBINSON: I would like to disagree with that point of view. I think that certain aspects of paleontology require ideally collecting everything possible. Letting stuff erode and totally disappear is a disservice to science.

MR. KING: As a rejoinder to that, one of the ideas at the Badlands that was proposed is, was, I don't know if this has been implemented, to let the beds ripen up, so to speak, so that in fact the entire weathering process, the rate of weathering of those specimens, could be detailed in a total pathonomic approach. And it was felt that a yearly collection, or an every so often collection, didn't really in fact allow us to get to the base line data level that a yearly collection or sweep of the specimen would give.

MR. CROUCH: Mrs. Goodrich, you had a question.

MRS. GOODRICH: This is getting back to the comment you made about the paleontologist. With our experience, it would be very helpful if there was some paleontologists at the BLM level because there is so much public land out here, but I wonder if it would be more economical and perhaps more beneficial if there was a state paleontologist rather than a district paleontologist, because the resources are all over the state. They aren't just in western Colorado.

MR. CROUCH: That's very true.

DR. SIMPSON: May I just add one thing more? I'm somewhat in the middle of the things that have been expressed, but close to Pete Robinson's view. Most of the mammals are small mammals. I'm largely interested in the collection of mammals and as regards small mammals. They are far more numerous in every fauna, in species and individuals. From the scientific point of view one must really have in order to understand what's going on in the history of these. For one thing, as they weather out they have absolutely no recreational interest. The average visitor isn't even going to see them, isn't going to know they are there and isn't going to give a damn if they are there. Another point is, for these, we do want to collect every single scrap on the surface, and we don't even want to wait and watch them weathering out. As a rule, for one thing, the scrap on the surface may be the end of a skeleton in-situ. That is a lead; you want to go in, you want to dig in and do so immediately before it weathers worse. All scraps on the surface may indicate that this is a washing locality whereby with this new washing technique, you may be able to pull out the entire small mammal form right away. But you'll never find that unless you find the surface scraps and collect them. Another thing about it, if I still may make another point, your resident paleontologist here is going to have to make decisions as to whether it

is worthwhile or necessary to collect the specimen or to leave it there or what not. In other words, he's going to have to make decisions as to the importance of this find. And by "importance", I, at least, mean the research importance as the potential contribution to knowledge or whether its contribution would be entirely recreational, which would be true in some cases. And if he's going to make decisions about the importance of the specimen, he's got to be trained in research. He's got to have an interest in research. You'll have to get somebody who's going to want to research himself, and I think it will be difficult to get somebody of that sort unless he has some facility for carrying on a research program within the area on his own. And also, if the paleontologist has a doctorate, you will have to pay what a beginning person with a doctorate now expects to get, which is quite a lot more than what you expect you would have to pay.

MR. CROUCH: Thank you. Your point is well taken.

MR. BARRY: On this whole thing of having a staff paleontologist, particularly with respect to the surface clearance work and also with respect to this issuing and waiting six weeks for this one permit, I'm getting a little out of my area. But my understanding is in Utah we have a number of institutions which have a generalized permit that allows them to do surface clearance work and I believe some salvage work on archaeological values anywhere within the state of Utah. And then when they are hired, say by an oil exploration company or whatever, to do the particular site, we have what is termed a mini-permit that just gives them specific authorization. That's handled at the district level, to go out and work the specific area that they are going to deal with under their contract. That is the way our district gets most of our archaeological work accomplished. Even though we have two staff archaeologists they are probably doing a minority of the actual field work. I would think some sort of an approach like this could be utilized.

MR. CROUCH: We have the same situation here in Colorado. We have a number of institutions that have permits for our district. However, the majority of them are on the eastern slope. We have one institution on this side of the slope that has a permit. The museum's permit is rather limited, and we have to follow the guidelines set out for us. These guidelines require an emergency permit, issued in Washington, for the removal of that fossil.

MR. RIPPETEAU: I have an opinion, too. Practically everyone that I know, as an archaeologist, and respect is heavily involved in research. Research involves rigorous curiosity. Now, there's no doubt that a staff paleontologist, in my mind, should have that attribute. I also think the guy should have, whether at the state level or distributed among different districts through part of the year, management capabilities. I have just been deeply impressed

with the contribution of having a plan for the resource, and you get a feeling for what everyone will agree to as being reasonable, and then you implement it. There is all this land. It is distributed among many laws; it's more diffused than cultural resource directives, but Congress did authorize certain public employees to go out and manage these resources, and they have an obligation by law to try to develop a plan. And one of the plans, in my opinion, should be to gather up everything that's being endangered, that's weathering out now; not to just sit around with a research project like it was an exercise, but to develop a plan for evaluating people, the merits of the project, acting rapidly in issuing permits, and he's got to devote half his time to thinking about what the next 50 years of paleontology should be as far as a land user is concerned.

MR. ERIKSEN: I think that you should get right out there and get it out of there and you can always write it up later. Sometimes you can't always tell every little thing you have got until you get it back, get it cleaned up. You can always let BLM or whoever is looking out after the area, know what you have got. But the main thing is to get out there and get it. I would say to keep the permit process simple, if it has to be a little form you fill out to do this, then let's get with it and do it. That's my whole idea.

MR. RIPPETEAU: I have two responses. One is that it was a big deal in the 1930s to go out and salvage archaeology sites. And then again in the 1950s under the Federal Highway Program go out and salvage. The only trouble with going out and salvaging is that people salvaged all this stuff and now they cannot remember what it was all for. We are trying it the third time around in archaeology now in this whole cultural resource thing, that that would be enough feedback to the people doing the salvage that they look at their techniques and rethink what they are doing practically at the time. I think that's why we are going to be different from the WPA days for this.

MR. ERIKSEN: I agree with that.

MR. RIPPETEAU: The other . . .

MR. ERIKSEN: You know, you have got to keep your finger on it.

MR. RIPPETEAU: Oh, I remember another thing in archaeology, and that is to stop responding to brush fire things and get ahead on the right side of the power curb. And to identify the outcrops in areas and have a good idea of what is happening instead of just this hit or miss; people calling up and saying, "Oh, there's something terrible happening, you know. Fly yourself out there and take care of it." You should be able to anticipate, make some plans, because there are limited resources. Anybody here that does not believe in limited resources . . .

MR. ERIKSEN: That's exactly what I have been saying.

DR. ROBINSON: I would like to make a comment. I have been begging one or another government agency for the last two years to, instead of doing all of these ad hoc EISs, to do an honest to God survey of the biological and paleontological resources, particularly in northwest Colorado, so that you know from a point of strength what you have got rather than finding out at the last minute. And we have gotten nowhere on this.

DR. RIPPETEAU: Yes, you have certainly tried. But that is one of the major directives, though, in the whole cultural management program of archaeology, is identifying in the first place. And that's why I think a paleontologist would be extremely valuable. Perhaps he would be funded off in the indefinite future, maybe a two year program, with a limited area, would identify and respond in passing to the things that come up, but make a plan, a two year plan, for the next 25 years.

DR. ROBINSON: I have mixed feelings on that. I think it's a great idea for government agencies to hire paleontologists because there's a lot of them without jobs at the moment. On the other hand, I have a general distrust of government agencies doing in-house reports. I think that the pressures that can be put on you from your supervisors or from Congressmen or what have you, end up with less than adequate reports. I know the Geological Survey did this. In one case the present crunch for energy, another one -- and I think that the more input there is from outside the government structure, the safer the science, whether it's archaeology or paleontology or biology, is going to be.

DR. RIPPETEAU: I agree with that. On the other hand, you started talking about planning committees which you said you deplore.

MR. CROUCH: Any other questions? Mr. Barry?

MR. BARRY: One other point in response to some of your comments. One the basis of what I saw yesterday plus the time durations that I'm hearing on this scientific interest in that site, I'm rather doubtful that all that outstanding recreation experience can be provided on-site. And you are going to continue to think in terms of on-site facilities. I would certainly suggest that you be thinking in terms of facilities that are mobile, that perhaps ten years from now you can move to another site. In the first place, you might be able to get them sooner and then if, in a few years, you find that the interest in this site is gone and it's somewhere else, you can move it. Now at the Cleveland-Lloyd, we are stuck with a pretty substantial investment for facilities and the scientific interest in that site is way down. And the recreational experience that we are going to be able to provide at the

facility isn't going to be all that prime. Again, ask those recreation questions before the facility development on the site goes forward.

MR. CROUCH: Thank you.

MR. MATLOCK: One more point Dr. Robinson mentioned was the creation of another facility, and my question to the paleontologists would be, what is the present status of your curatorial needs throughout the country? Or are you again like archaeologists? Are you bursting at the seams with most of the facilities that you have right now? Are they being adequately curated across the country? Do you have situations where supposedly fine institutions are in fact not curating? The material is being lost wholesale; and would it not be valuable to have a curatorial facility and perhaps as an alternative to existing facilities, to help establish standards for states and things like that?

DR. ROBINSON: To answer your question, throughout our profession we have a serious problem maintaining our collections, primarily in the case of space and curatorial furniture, cabinets and to a large part, personnel. But I think the space and equipment are the real problems. This situation should be relieved in the next year or two, thanks to the National Museum Services Act which was just passed last fall. In regard to a second facility in this area, I think it would be much more economically practical to upgrade the existing facility with additional space and so on than it is to create another one.

MR. BENTON: Just a couple comments, John. I seem to sense that you would be working at cross purposes if you didn't have competent paleontologists you hired yourself. One of the major complaints seems to be that permits are not issued promptly enough. Now, if you don't have a man here on the ground to make the decision, how are you going to do it? And I think BLM has, as you know, hired a vertebrate paleontologist; he's the son of Professor Rigsby at Brigham Young University. He was hired within the last month and he's presently on duty in the Albuquerque office. So you do have some people; I sense empirically that you have a need for such people. I get an average of, I suppose, seven to ten calls a week from different BLM offices wanting a bit of advice or decision of some kind, sight unseen. They are doing their best, but they have no one there to make the decision, and I have gotten this at all levels from district offices, state offices and from the subdivisional offices in the district. A lot of the people have gone to the trouble to come to the Federal Center to discuss the problems further. I have done the best I could for them. It's a surprising demand for information. And I have had the feeling that the Bureau has been in there doing its very best under extremely difficult conditions.

MR. CROUCH: Thank you. Any more questions?

CHAIRMAN: George Shank is sitting in with us. George is an acquaintance of Dr. Callison, and as I understand it, knew about some of the locations of some of these things and showed George how to get to them. We are glad to have you, Mr. Shank. He lives down in Fruita; he's a teacher there.

Our next speaker is Dr. Nicholas Hotton.

DR. HOTTON: My topic has changed considerably from what I originally advertised. This seems to be a feeling that all of us have, so I'm not going to apologize for it. But at any rate, as it stands at this minute, I've got two main aspects, definitions, circumstances, of dinosaurs that I want to talk about. One is very broad indeed, and that is regional stratigraphy, which George Callison touched on briefly.

The relevance of this aspect to the sort of thing that we are talking about these days is the same as the relevance of any kind of national park; is the preservation of scenic beauty, because this is all extremely broad scale. This is the sort of thing where you can stand on one side of the river and look out on the other side of the river and human activity such as rock hounding and pot hunting isn't going to make much difference. What may make a difference, of course, are things like superhighways and parking lots and that sort of thing, which are also problems but not really germane to the present discussion. The other aspect I want to talk about, still on broad level, but somewhat finer detail, and that is the immediate circumstances of burial of dinosaur bones and what it means to a scientist and how it may actually bear on what we are talking

about. I can take care of the second part first very quickly, and that is that the immediate circumstances of dinosaur burial are either going to be preserved because they are such big scale things, or they are going to be lost to scientific value because the guys that are doing the collecting don't take note of them. Well, this still happens but it happens less and less frequently all the time. Several of our speakers have referred to the business of collecting all the data you can get, the pathonomic information on the circumstances or on the kind of sediments the thing is found in and that sort of thing. So as I say, a good deal of what I have got to say has been anticipated and I'm going to get at it, get through as quickly as I can.

George pointed out yesterday that in the area of the Morrison two members are recognized: Brushy Basin, younger, and Salt Wash, older. Now that's fine as far as it goes, but there's a little bit more to it than that. I want to address myself to that in this dimension. In George's diagram we have time, but we also have a change in these relationships in space dimension. From roughly the southwest to northeast, and by southwest you can take as a data point Four Corners and extreme northeast you can take as the data point central and eastern Colorado and southern Wyoming. Our time dimension, I'm not going to talk about millions of years or anything like that, but simply use the terms that George started off with, Brushy Basin the top and Salt Wash the bottom. Okay. In the extreme southwest, the Four Corners area, a little bit of Colorado extending up this far north, as a matter of fact. And in Utah, well, the Four Corners area, we have two members interpolated between the Brushy Basin and the Salt Wash. The other one is the West Water Canyon. This is all secondhand. I got this from the U.S. Geological Survey, so if you want to argue about it, argue with them. Okay. West Water Canyon and the recapture. First of all, Salt Wash recapture and West Water Canyon are fairly coarse sediments. Sandstones are thicker; sandstones, you might say, even predominate. Sandstones and conglomerates predominate the intercollated shales. Shales are relatively thinner; they are green rather than rainbow colored as they are up in the Brushy Basin. The contrast with the Brushy Basin is that the sandstones are far thinner. There are fewer of them; they tend to be finer grained and the shales, in consequence, are much thicker. There are variegated. You saw them yesterday. Now, Lance regards his immediate locality as a Salt Wash and he's probably right. I'm sure not going to argue with anybody, as little as I know about this immediate area. And going on that assumption, if you recall yesterday standing on George Callison's locality and looking off towards Fruita, you could see the walls of the fills opposite us were green and there was a lot of sandstone, especially at the top of them. Above that and on the hill that we were on, the clays and shales tended to be all stripes, red and buff colored, and this is what we mean by variegated. That's the way the situation is here. But as

you go northeast the situation changes. The Brushy Basin lithology, this variegated clay, relatively thin sandstones and all the rest of it continues without change over into the east, but it becomes thicker and it's believed that the lower parts of this Brushy Basin facies are time equivalents of the lower members over on the east. In other words, these things have changed their lithology as you go east and become indistinguishable from the Brushy Basin. What lithology? I've already talked about it; I've already suggested that they are coarser relative to the dominance of finds in the Brushy Basin. There are some interesting items, for example, in the Salt Wash, there are four distinguishable facies. There's a sandstone conglomerate facie, a sandstone facies, a sandstone claystone facies and a limestone facies. The recapture, the limestone drops out and the Westwater Canyon, the sandstone clay facies drops out. You wind up with primarily sandstone conglomerates, central conglomerates and sandstone conglomerates, and plain sandstones. And this is why a rule of thumb for saying you're either in Brushy Basin or the Salt Wash, is the thick sandstones that you get at the top. What? Maybe Westwater Canyon. So what you have here is a coarsening. The Brushy Basin is finer than everything else, but as you go up this pre-Brushy Basin sequence, it gets coarser and coarser. And the reason is, apparently, that at the source area of the Westwater, of the Salt Wash, is over in California, whereas the source area recapture seems to be somewhere around Gallup, New Mexico. In other words, you're getting closer to the source area as you go up in time. And as a consequence, the water flowing faster, the erosion is faster and you're getting coarser material. Then you go up into the Brushy Basin. By that time, uplift has ceased. There was a certain amount of regional uplift in this period. Uplift ceased, then, by the time you get to the Brushy Basin. Erosion has taken down those source areas so they are in effect -- all right. Erosion has taken it down and you're only getting the fines. Now, in terms of circumstances of the fines, the Salt Wash recapture and Westwater Canyon are spoken of as alluvial plain or alluvial fan, and the Brushy Basin is said to be fluvial. By an alluvial fan, or an alluvial plain, what is meant is going from the southwest to the northeast; you get relatively narrow limited deposits expanding like your source over here, your water courses passing out this way. You go from coarse near the source to fine around the periphery. Now, that is pre-Brushy Basin deposition, but it doesn't explain why at this time over here in the east you can't distinguish what you have got from the overlying Brushy Basin. There's some more details about that which I think we can leave out. Distinguishing between the alluvial fan tile of deposition of the pre-Brushy Basin and the fluvial tile, the cuspering deposition of the Brushy Basin itself, the main thing is that the stream courses seem to be braided in the alluvial fan bit, which presumably indicates that they are carrying very heavy loads. There is some indication, or at least I have seen it in the literature, that some people think that the pre-Brushy Basin was actually a bit drier, less humid conditions that you encounter later in the Brushy Basin. And some people even suggest that's why you don't get so many dinosaurs prior to the Brushy Basin

time, and I don't believe it. I think there's got to be other reasons, deposition reasons, luck of the game. Why don't you get the dinosaurs down there?

The fluvial tile water course, on the other hand, seems to be more meandering and less braided. They were not carrying such heavy loads except at intervals when you had catastrophic flooding.

Now, I want to talk very briefly about the kinds of sediments. There's all kinds of detail that I can go into, but I'm not, partly because I don't know that much about the immediate problem and partly for the reason of time. To begin, we can distinguish between the coarse sediments, sandstone and in some cases, conglomerates and the fines, claystones, soapstones. The coarse sandstones in particular appear in outcrop, very often lenticular and that remains of various kinds of channels. In the channel environment, you get high energy circumstances which is marked by sandstone and low energy marked by clay pebble conglomerates. Some of you may have seen, as we were goind over to the Ceratosaurus locality, Glory Hole locality is the wrong term, the big tumble blocks of sandstone with nice, beautiful, big clay pebble conglomerates. One of them even had what looked like a nice metapodium bone of the dinosaur in there, which was functioning sedimentilogically exactly the same as the clay pebble conglomerate. It was a lag deposit. These clay pebble conglomerates are said to be low energy because it appears as though, as the stream lost velocity it dropped the larger chunks and winnowed the fines out. So you get the concentration of the coarse material. I think there's another factor in this. Clay pebbles very often originate as a result of collapse of stream banks and they are not very persistent. They dissolve; they'll wash away very quickly. And if you get them it's an indication that deposition has taken place quite quickly there as a result of dropping velocity. Those are the intrachannel conglomerates. You get clay pebble conglomerates also marginal to these putative channels which supposedly indicate levies, also a matter of drop in velocity of a stream as you go out towards the margin. Now, there's another factor here which is not visible at the locality. At least I didn't see it. It may be true, actually, of the matrix surrounding the specimen, but I would not want to bet on it. Next the question of sorting. In a high energy stream channel you have relatively clean sandstones, not that much clay mixed in with them, and a lack of any concentration of vegetable material, disseminated carbon and that sort of thing. The dirtier the sandstone is the more drop you find in them. It's not necessarily a matter of reduced velocity. What it indicates more likely is a greater bed load suggesting flood conditions, perhaps catastrophic flooding conditions.

Okay, so much for the coarse sediments and the ramifications. Briefly, the fines, the siltstones and claystones can be summarized in terms of -- well, let's call them, for the sake of

argument, flood plains. Over bank deposits they are sometimes called, and there's a variety of them. But primarily they occur lateral to the channel; in the Brushy Basin they tend to be variegated. They do contain small siltstones or fine sandstone stringers, perhaps tributaries to the main channel or perhaps distributaries formed during times of flooding. Sort of a small scale grading effect. A true over bank deposit may also contain mud cracks, rain prints and tracks. Now, we didn't see them, but I do understand that there's a nice -- is it a clay -- below the level where you get your footprints, or is it sandstone?

MR. ERIKSEN: Well, there's the sandstone that the tracks are in, then it's clay again, yes, right below that level.

DR. HOTTON: What's above the tracks?

MR. ERIKSEN: Clay again.

DR. HOTTON: Then the tracks are in sandstone?

MR. ERIKSEN: Yes.

DR. HOTTON: Okay. So you have got sandstone over bank deposits. Okay. You can get that kind of over bank deposits, for example, during a flood when a levy is breached; the stream is carrying a lot of relatively coarse material and you get a fan shaped or broadly, thinly lenticular sands dump over the clay and then at a later phase in the cycle the clay deposition resumes as over bank deposits. That may be the sort of thing you're dealing with, but it's the same general environment. Also in the over bank deposits, including the levies, you may sometimes get evidence of soil formation. That is indication of former presence of roots, oxidized zones, nodular zones; I don't understand the chemistry of that, but I do understand from reading that nodules are supposed to indicate in some circumstances "soil horizon". Now, we have another set of fines which may be rather difficult to distinguish from the over bank deposits I have been talking about, and that is the lacustrine. Remember that I said the Brushy Basin is supposed to be fluvial tile lacustrine. We have been talking about the fluvial tile aspect of it. The way you distinguish a lacustrine clay from an ordinary fluvial tile over bank deposit is difficult. First of all, the color may differ. It will be a variable color, but the color will be very often in very distinct bands of very considerable lateral extent instead of the more or less blobbiness of the variegated shales. It seems to be yesterday, looking at the putative Brushy Basin at the locality, that a lot of this seemed to be very markedly banded, and may very well be lacustrine. Lacustrine deposits may appear to be all in the channel, but they lack all the other features such as small siltstone or fine sandstone stringers or mud prints, mud cracks, imprints of tracks. And also evidence of roots are lacking. There is another factor, I didn't see it yesterday. I

don't know whether it occurs in the Morrison or not, but I sure as heck know it happens in the Permian. You get banded sediments, and sometimes right in the middle of a band you'll get extremely reduced layers. The general color of the sandstone or of the clays in the Permian I'm familiar with tends to be red, but you have great zones of greenish or greyish where the iron which causes the red has been reduced. It's still there but it's gone from ferric to ferrous and the color has changed. That seems to have occurred as a consequence of the accumulation of organic material in water sealed off from the air under conditions of low oxygen. And this kind of criterion is also said to indicate ponding or Lacustrine conditions. Now, just let me try to wind this up with a bang. And one of the things I did in preparing for this, I told you that my plans sort of changed as I went along, but I did find that there was an awful lot of detail on the fine detail of the occurrence of some of the classic dinosaurs. Marsh's people, while they weren't trained as geologists, were good observers and the fact that they made quarry maps is extremely useful. Here are some of the things that seem to be emerging. Two references, one of Hatcher's, talking about Canon City; another one of Gilmore's talking about Dinosaur National Monument. In both of these localities the primary occurrence of bones seem to be in sandstone. The description, as you can credit it, seems to be very similar. Hatcher calls the Canon City stuff thick, fine, hard sandstone. Gilmore calls the National Monument material heavy, grainish, cross-bedded sandstone. I have been to both places, and they do seem to be consistent. At the Canon City locality what do we have? Hatcher was talking specifically about two Sauropods, Laplatasaurus both of them. One of them, however, was about two-thirds the size of the other. In addition to those reported from Canon City are two other kinds of Sauropods, a Ceratosaurus, Allosaurus, Stegosaurus, turtles, fish and mammals. But you can see, first of all, that Sauropods dominate. The Dinosaur National Monument, Sauropods predominate again. Again, they are referred specifically to one, two, three Sauropods, six others reported from there, one Carnisaurus, four Ornithischins and crocs and turtles. However, there is considerable difference. There seems, at least in the superficial way I have been able to touch on it, to be considerable difference in the mode of preservation. The two Haplocanthosaurus the columns were partially articulated. That is, you get a string of dorsals and a string, in one case, a string of cervicles. In the other case a string of tails, vertebraes. But that was all that was articulated. Everything else was scattered around. At Dinosaur, on the other hand, you get some fantastic well articulated and associated material. This particular reference to Gilmore -- Gilmore refers to a Camarasaurus, which was complete and articulated. The only thing that was wrong with it was that the shoulder girdle seemed to have slipped downward, or the rest of the carcass slipped upward, and there was a little bit of displacement of the elements of the hip. And everything else was complete and articulated. It looked like a museum specimen. We have a beautiful Camarasaurus at the National Museum,

which comes from Dinosaur. It's my understanding that that thing was very well articulated, too, but this account of Gilmore's refers to a specimen. The specimen he refers to is at Carnegie. Now, does anybody know -- do you know if the U.S. Center specimen was that well articulated?

MR. KING: Are you talking about the skull?

DR. HOTTON: No, I'm talking about the whole skeleton.

MR. KING: No, but I think we can find out easily enough.

DR. HOTTON: That would be a remarkable record. Two completely articulated Sauropods.

MR. KING: It must have a catalog number with it.

DR. HOTTON: Yes, as a matter of fact. Well, I got the catalog number with me. I'll get it to you later. That's in marked contrast to the sort of thing that Hatcher was talking about at Canon City. And also in contrast to most other occurrences except some described by, most recently by Peter Dodson, up in the upper Cretaceous, the old man formation in Alberta -- however, no one get the idea that everything is well articulated at Dinosaur because it's not. Saurapods tend to be articulated in a number of strings. There may be an association between the limb elements, or there may not, and there's a great range of condition of preservation. Now, by contrast to that, we can go to Quarry 13 in Albany County, Wyoming. Gilmore calls the sediments in which the most bones are found a sandy clay intercollated with beds of marrow. Both of them sandwiched between two thick layers of sandstone. But the bone was not in the sandstone; it was in the dirtier stuff in between. Okay. What do we have there? We have got four Stegosaurus, five Camarasaurus, Leosaurus, Morosaurus, Sellosaurus, Allosaurus, turtles, crocs and fish. The most important thing there is that the relative lack of Saurapods, predominance of Camptosaurus and Stegosaurus. So you might say it does sort of look as though there's a difference in the kind of environment in which -- I mean, the kind of environment in which -- I mean, the kind of Phinatacenos in which we are going to find these animals. Well, I would like to be able to stop there, but unfortunately I've got to stay honest and refer you briefly to the Bone Cabin Quarry in which the description of sediments sounds very much like the description of the sediments at Quarry 13. Loomis says that the sandstone varies from soft and clay, workable with an awl, to bands of the firm of sorts. He doesn't say specifically which the bones came from, but he says Sauropods predominate. So there goes the old ball game. There is a lot more data than I have presented, to suggest that this should be followed up. The whole business that I have been talking about is much more germane to the scientific content and it depends on the experience and ability of the people that are doing the scientific

work. What I'm trying to say, basically, is that this information can be, as it's gathered, it will be available for whatever kind of presentation that you're going to present for the educational aspects of it in your own utilization of the land. And I think you'll find that enough people will be interested in it to make it worthwhile to utilize. It is one of your resources. And, oh, one more point, and that is that since the Fruita area has not been so extensively exploited as some of the other areas, there's probably a great deal more potential to develop this sort of thing as collection goes on. Thank you. Ed, are you going to give me a hard time about topography?

MR. LEWIS: No, I try not to give anybody a hard time, but I did want to add something. You're speaking of time; it's harder -- otherwise, you did mention time at the beginning.

DR. HOTTON: Yes, I did, didn't I? I forgot to emphasize it.

DR. LEWIS: I wanted to add a suggestion to the people who develop the Fruita locality. I'm still thinking in terms of your southwest to northeast, something to look for in the Morrison if you can get the kind of evidence that permits it. I don't know whether you'll be able to. There hasn't been nearly enough done. But I would draw an analogy with the Cretaceous; I'm sure all of you know how time lines and stratographic lines transgress each other at a marked angle, if you please, in the Mesa Verde, coming up from the coal fields down in Arizona, New Mexico, to the Rock Springs uplift where the comparable rocks are far younger as you move north and northeast. And that has been reduced to a situation where you can apply time criteria. How many of you have read the published results of the researches of James Gill and Bill Coffin on this with respect to the Fox Hill sandstone just below the Hill Creek alliance in Wyoming and Montana? Well, in a word, it's this. One million years, fifty-five kilometers as you go from southwest to northeast. This has been pinned down now pretty accurately, so that with the stratographic boundaries like this, the time boundaries cut across the same way as in these other situations. And where in Montana and Wyoming you have a given age fifty-five kilometers away northeasterly, in Dakota it's a million years younger, exactly the same facies. And who is it? I'm sure some of you have read the dissertation that came out last year on North Dakota Paleocene maps. I think it's Holtsman or some such name. But at any rate, he picks this idea up and makes a fairly good case for the Mesozoic mammals in Fort Union being far younger than they were thought to be before, insofar as North Dakota facies is concerned. He says . . .

DR. SIMPSON: You don't mean Mesozoic. You mean Paleocene.

DR. LEWIS: I'm sorry. I was thinking Paleocene. This is Fort Union and they seem to be the very top of the Fort Union, up in North Dakota. So you might be able to demonstrate a comparable situation here in the Morrison. It's been mentioned several times it would be well to make a comparison between Quarry Nine and the Fruita locality. There's one line of research that might prove to be very profitable.

DR. SIMPSON: One small point. If you are through, Ed.

DR. LEWIS: Yes, I am through.

DR. SIMPSON: Somebody asked me yesterday whether there was some means of getting radiometric dates here. One should, however, bear in mind that there's also paleomagnetic dating with reference to Fort Union. That made me think of that, because of the University of Arizona. They are now working on running that through the late Cretaceous and through the Paleocene and already started going up through the Fort Union and the San Juan Basin, so that the possibilities of getting that paleomagnetic data requires a special field technique, because you have to take oriented samples. It's not a matter of collecting specimens of fossils, but a matter of collecting specimens of rock, especially of clay or of reddish rocks and getting out an oriented specimen in which you know exactly which way was magnetic north where you took it, and exactly what the depth of the needle was that was there, and then find out what it was when the deposit was laid down. And these have been variables through time. And we have now got quite a good sequence starting in the late Cretaceous and running right through the recent.

DR. HOTTON: That's another thing that can be exploited in this locality is the time dimension poses. I didn't emphasize it, but it is another intellectual resource. Incidentally, George, in that connection there are bentonites in the Brushy Basin. I don't know if you can get potassium argon dates from the bentonite or not.

DR. SIMPSON: It all depends. Bentonite, of course, usually are altered ashes. They are usually too altered to get radiometric dating. Usually they won't even give you a paleomagnetic dating, so bentonites are poor for dating.

MR. CROUCH: Our next speaker is Mr. Russ King. Thank you, by the way. An abstract of Mr. King's presentation has been placed in front of you earlier this morning.

MR. KING: Thank you, John.

Well, following Dr. Hotton's lead, I think I'll deviate a little bit from what I had started on. And what I'll do is read you a little on the history of the Dinosaur National Monument quarry and some of the circumstances under which it was placed under the

protection of the Department of Interior, from some remarks prepared by Dr. John McIntosh, for a publication about an article about Dinosaur National Monument in Fossils magazine. Then I'll read the prepared remarks that most of you have a copy of. And then hopefully and gladly at the end, show you some slides of our beautiful specimens, and then toss it open for comments and questions, which I hope you'll have.

The greatest and one of the most scientifically important dinosaur quarries ever discovered is located in the western part of Dinosaur National Monument, seven miles north of Jensen, Utah, not far from the Colorado border. The efforts of many workers, scientists, collectors, museum preparators and administrators have combined to make this vast cache of nature's treasures available to science and the general public. Three of these stand out beyond the others. First, there is Earl Douglass, the discoverer of the quarry and mastermind of over fifteen consecutive years of collecting. Second, there is Dr. W. J. Holland, director of the Carnegie Museum in Pittsburgh, and simultaneously curator of vertebrate paleontology, whose unflagging interest and enormous drive made it possible to assemble and finance the large staff and facilities necessary for the collection and transporting of tons of fragile material to Pittsburgh. Finally, there is Dr. Theodore White, who planned for and oversaw the development of the spectacular in place exhibit of dinosaur remains in the quarry at the visitors' center.

The discovery of the dinosaurs was in August of 1909. After several years of its operation, museum officials, fearful of its possible damage by vandals and others, tried to protect the site by filing for the mineral rights. The claim was disallowed on the grounds that dinosaur bones should not be considered minerals in the usual sense. Another avenue had to be found to protect the quarry. What finally emerged was a plan designating the area containing the quarry as a national monument under the supervision of the Interior Department. Anyone wishing to collect inside the monument's borders would henceforth need to obtain a permit. The Dinosaur National Monument was proclaimed by President Woodrow Wilson on the 4th of October, 1915, and the Carnegie Museum was issued permits to work the quarry on a yearly basis from then until December the 31st, 1923. The original area of the monument covered 80 acres surrounding the quarry. It was expanded to 318 square miles in 1938 to include much scenic country in both Utah and Colorado, including canyons of the Green and Yampa rivers.

That is a little historical background. Now, with this vast background of information about sauropods, for those of you who are not familiar, John S. McIntosh is the authority in this country and the world of Sauropods, and 75 to 80 percent of the specimens at the monument are Sauropods. This section of McIntosh's report is entitled Comparison with other Major Dinosaur Quarries.

Most of the dinosaur remains found in North America have come from two rather restricted time periods, the older representing the beds of the Upper Jurassic period, the younger of those of the Upper Cretaceous. While complete, or nearly complete, skeletons are more common in the Cretaceous, particularly in the Red Deer River valley of Alberta, these skeletons are usually found isolated, not jammed together as sometimes happens in Jurassic strata. There are half a dozen or so Jurassic quarries which have produced extraordinary numbers of bones of many individual dinosaurs. And somewhat surprisingly, the yields of each of these are strikingly different from one another. I was happy to see that Dr. Hotton mentioned one of these quarries and provided me with an opportunity to give you a little background on these. Perhaps the foremost rival to the Dinosaur National Monument is the famous Cleveland-Lloyd Quarry located eight miles east of Cleveland, Emery County, Utah. Indeed, a recent report by Mr. James Madsen reveals that the total number of bones taken from that site exceeds the number from the Dinosaur National Monument quarry. On the other hand, the total bulk and diversity of forms was less, for the great majority of the bones belonged to one animal, the carnivorous Allosaurus. At all other quarries, carnivores formed a relatively small percentage of the total. Another oddity at the Cleveland-Lloyd site is that no articulated skeletons were found. In fact, according to Madsen, the carcasses had become so dismembered that it was usually impossible to determine that any two bones belonged to a single individual. A number of skeletons of Allosaurus and several other genera as well have been mounted at different institutions, but these are all composites, the bones having been carefully sized from articulated skeletons. Another famous dinosaur site is the Bone Cabin Quarry north of Medicine Bow, Wyoming, worked for seven years at the turn of the century by the American Museum of Natural History. As at the Dinosaur National Monument quarry, the large Sauropods and, for those of you who are not familiar with Sauropods, they are long necked, long tailed four legged types. The large Sauropods far outnumber all the other forms, but unlike Dinosaur National Monument, only a single Sauropod skeleton sufficiently complete for mounting was recovered. It was a Diplodocus and was sent to Frankfurt, Germany. Three non-Sauropod dinosaur skeletons from the Bone Cabin Quarry, Stegosaurus, Ornitholestes, which is temporarily removed for study, and Camptosaurus are mounted in New York. The Sauropod remains consisted largely of limb bones and an inordinate number of articulated feet, which normally were quite rare, as well as segments of tails. On the other hand, vertebrae from the neck and trunk were very rare. Two fair Sauropod skulls were found and some scraps of others. Another major American museum quarry, the Howe Quarry, located near Shell, Wyoming, produced in direct contrast, a large number of articulated necks, trunks and even sacra, which would be the hips of Sauropod dinosaurs. A quite different assemblage of fossils came from the Yale Marsh Quarry, thirteen miles east of Como Bluff, Wyoming. Here, Stegosaurus was

the predominant animal. And the usually rare Camptosaurus also abounded. No fewer than three mounted specimens came from here. Although greatly outnumbered by both the above animals, one Sauropod, Camarasaurus, was fairly common. But not even a single bone, not even a tooth of Allosaurus or any other large carnivore, was found. This renders the quarry almost unique. On the other hand, a skeleton of the very rare small carnivore, Coelurus was found. The Marsh Felch Quarry at Garden Park, Colorado, was distinctive for another reason. It produced most of the dinosaur skulls in the early days, namely those of Diplodocus, Allosaurus, Ceratosaurus and Stegosaurus. The only complete skulls of the Ceratosaurus and Stegosaurus come from this quarry, so Lance's find, as you can see, putting that into perspective, is quite important. The complete skulls arbitrarily referred to as Brontosaurus by Marsh, also came from here. Perhaps the most complete Sauropod in this quarry was Haplocanthosaurus, which has been found almost nowhere else. Now, that's probably because it is in the Salt Wash rather than the Brushy Basin. Finally, there is the Dry Mesa Quarry recently worked by Dr. James Jensen of Brigham Young University. Preliminary reports indicate that the largest dinosaur ever found came from here, and that there may have been several other new animals as well. Their precise nature must await preparation and study.

Prior to this, then, McIntosh has gone into the reasons for the establishment of the dinosaur quarry. So in summary, he says it can be seen that while each of the quarries possesses areas in which it surpasses that at Dinosaur National Monument, overall the latter has produced the greatest bulk of material, by far the greatest number of articulated skeletons of different kinds of animals and by far the greatest number of Sauropod skulls. So that's a comparison on the different quarries, and we can use that as we need.

Okay. The remarks that I prepared here for the meeting today most of you have a copy of, and I'll simply read these. Perhaps this will give a little bit of background as to some of the questions, comments, that we were discussing earlier about the difference between an area, or a quarry, managed by BLM land or Forest Service and the National Park Service. So bear with me and I'm sure we can tear into this and find some meat for discussion.

The cornerstone for any National Park Service management policy must address the enabling legislation, specifically that portion of the Organic Act of 1916 that established the National Park Service, to conserve the scenery and the national and historic objects and the wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Kind of a tough road to go. The idea of an in-place quarry operation at the Douglass discovery site stemmed from notes in Earl Douglass' diary. Lying at the extreme northeastern edge of the Colorado Plateau, the hogback forming channel sandstone deposits of the Morrison formation weather out as positive features on the landscape. The well-cemented matrix has allowed the beds to dip at nearly a seventy degree angle to the horizontal plane without distortion to the fossil bones. Consequently, any portion of the slab that was relieved in sufficient detail should exhibit dinosaurs in the most natural way possible. In addition, the in-situ dinosaur display would lend credibility to fossils seen most generally in museums by the general public. At the outset, it was hoped that the excavations would reveal a completely articulated specimen. Today, this lack of an articulated specimen is clearly the visitors' chief disappointment, if you can call visiting the Dinosaur National Monument Quarry a disappointment. We'll come back to that later as there are some reasons for that. Primarily, this is due to visitor expectations and the brevity of the visit. Nonetheless, there are other aspects of the reliefing operation that have nearly overshadowed the dinosaur deposit itself. This has been an immensely popular aspect of visitors serving as sidewalk superintendents in the reliefing process. The two full-time preparators and the work that they perform seem at times to rival the interest of the dinosaurs among the adult visitors. Children, of course, are still primarily interested in the fossils themselves. Interest in the reliefing process itself is most clearly evident when schedules, personal affairs and/or cold weather force the preparators from the quarry itself into the preparation lab. It seems to me that the visitor feels that he has been denied something if the bones are not being reliefed while he or she is viewing the exhibit.

Perhaps in conjunction with the above remarks, some mention should be made of the sales/information desk. Allowed to, "Take only pictures and leave only footprints", sales of educational and interpretive materials have averaged $1.00 for every three visitors in the most recent year, 1976. The average visitor spends only about 35 to 40 minutes touring the museum, with visitation in the summer reaching a peak of 2,500 people per day. Difficulties sometimes arise in conveying the full significance of the quarry to the visitor given the number of people and brevity of the visit. And this is something that we will want to talk about more in terms of trying to serve both scientific interests as well as the recreational and educational aspects. What, then, is the dinosaur quarry today? Very simply, a museum where the public can view exhibits about dinosaurs while observing the careful preparation of beautifully preserved specimens. Freeman Tilden, a man with a vast knowledge of the National Park System, has stated very well the meaning of the National Parks.

I quote here, "So we see that the National Parks are really national museums. Their purpose is to preserve, in a condition as unaltered as humanly possible, the wilderness that greeted the eyes of the first white men who challenged and conquered it." Challenged and conquered it might not be the best words today, but that's what he wrote. "It is to insure that the processes of nature can work, without artifice upon all the living things as well as the earth forms within their boundaries. The parks' purpose is to keep intact in the wilderness areas all the historic and prehistoric evidences of occupation by our predecessors.", which would include dinosaurs, too. It is my own personal belief that the ultimate value of the reliefed exhibit at the quarry will lie in the subdivision of paleontology known as taphonomy. Taphonomy is concerned with the factors intervening between a living fauna and the fossilization of a fraction of it. It deals mainly with the post mortem history of animal remains, especially their decay, transportation and burial, but also with the cause of death.

I would like to address the subject of expenses. Dr. Robinson brought up the idea of the justification for a paleontologist. I thought you might be interested in some of the visitation facts, and this is what I came up with. Summarizing very briefly the vital statistics of the quarry operation, we have nine permanent staff members at the Dinosaur quarry, which is a district of Dinosaur National Monument, one of the two districts. Four of the staff are in the interpretation division, including the paleontologist and the two preparators. Two are in the ranger protection division, two in the maintenance division and one is the business manager for the cooperating association that operates the sales desk. These staff members are supplemented by approximately fifteen part-time employees throughout the divisions to handle the increased visitation in the summer months. The operating budget for the Green River District, which includes two campgrounds, four houses and seven vehicles, is approximately $325,000 for the fiscal year 1976, which is almost one-half of the park budget. The annual visitation to the quarry, in 1976 was just over 300,000 people, with about two-thirds of that number confined between Memorial Day and Labor Day. So we are basically a summer operation. Gross sales at the cooperating association was approximately $105,000. As mentioned, the average visitor spends approximately 40 minutes in the museum visitor center.

Several professional paleontologists visited the quarry for specific studies in 1976. Approximately 30 college groups visited, mainly geology groups in the summer. Many elementary, junior high and senior high school students spent time at the quarry while on school sponsored field trips. Many written requests from school children studying dinosaurs were answered with free written handouts. And here comes a somewhat touchy area. Having been limited to just two years at the quarry, I'm not sure exactly

how research in the National Park Service is administered, but I'll give you what I have from my viewpoint up there. Research in the National Park Service is limited to projects that will improve the management of the resources in question. Today it is generally accepted that the dinosaur resource is well understood for the purposes of interpretation. And maybe we could underline that (purposes of interpretation). On file at the Monument are the written suggestions of Professor John McIntosh, whose article I quoted from earlier, regarding the special items of Sauropod research left to be answered at the quarry. Current research at Dinosaur National Monument is directed towards the defining and quantifying river rafting activities and grazing problems that are unique to Dinosaur as one of the few NPS areas that includes grazing of domestic livestock. Okay. I think that's all I want to talk about in terms of the prepared remarks. I have a little bit here that I jotted down throughout the meeting that I wanted to mention.

It would seem from my viewpoint as a paleontologist up there that when we are dealing with the amount of money generated by the sales and information desk, and the number of people that we have, part of our responsibility ends up accounting for that degree of money and visitor safety. And so at times I felt up there that the purely academic scientific research kind of activities are in a sense relegated to less than first class status, because we are having to account for monies and safety of a large number of people. Another thing that has impressed me as being a problem, something that might be improved upon in future kinds of operations would be the actual protection of the quarry and the visitors' center itself. And that is that while the four houses, one of which I live in, are approximately a half a mile -- located a half a mile downhill from the quarry on the old Green River flood plain, the quarry itself is out of view of the housing area. So on the road leading up to the quarry we have a gate that's locked when the Quarry is closed, but -- there have been occasions where motorcyclists and even a Volkswagen was even able to negotiate the gate and breach the security, so to speak. It's difficult to always keep an eye on that invaluable resource. The other thing that was difficult for me to deal with after coming out of school was the idea of running a seven day a week operation pretty much means that if you're going to have full-time people, you effectively double the staff. What the people want to see is, as I alluded to earlier, is some work on the quarry. Well, the government expects good, hard work from its employees, but not seven days a week. So in fact we have two preparators, full-time preparators there, so that we can have a seven day a week coverage. Now, they are not thinking of two paleontologists yet, but we do have the double numbers of people, so to speak, because we are a seven day a week operation throughout the year, not just in the summertime. And so it puts an extra burden on the tax dollar. Included in those figures that I cited for the operating budget for the district --

you have quite a bit of acreage to cover as well as the quarry where most of the people are centered. Another difficulty that I have noticed, in reading through Dr. White's correspondence and memoranda, is the changing of the management, which in the National Park Service is centered in the superintendent. You often get a fairly significant change in the direction from the management level. In other words, Dr. White was at Vernal and the Dinosaur quarry for some twenty years. I don't know how long I'll be there. The continuity is solid there, but with respect to a management and ideas and background, I think in seven years they had four different superintendents at Dinosaur before the last superintendent. So, you get kind of a cross current of winds with respect to direction and management from up top. In terms of a very brief personal recommendation as to what might happen down here at the Fruita paleontological area, I would recommend that an individual like Dr. Callison be called in to do the work, largely without public involvement. A persistent idea among people in the National Park Service and our regional offices is that people participation would be a very valuable thing regarding paleontology. And I think that we would all agree, learning by doing is a valuable experience. But the hardness of the matrix of the materials up at Dinosaur and the value of the specimens is such that we could never seriously entertain any kind of people involved operation like Mr. Barry mentioned down at the Cleveland-Lloyd Quarry, which I think on a limited basis is possible. And when we have our college groups and school groups come in who have made appointments, we take them back into the laboratory, we show them close up what's going on. Rarer yet, we do take groups, small groups, with myself or one of the two preparators, up on the cliff and show them the individual specimens up close. But it's a case where we do that with probably one to two percent of the total number of people. And I think that's only fair. 300,000 people with nine permanent employees is just impossible to try and keep a seven day a week coverage. Okay. So the recommendation would be that the team or the excavation be done by an individual as a team effort, and be done without public involvement. Then afterwards, do the interpretation, explain why, what approach was taken, why it was taken, something along these lines. And in terms of a permanent facility there, I would wait till after the work has been largely completed, or enough of the task has gone on to "prove up" the site, so to speak. Let me make one more comment, then I'll show you some slides and then open it up for questions, which I'm sure you'll have. Let's turn on the slide projector, if we can, and I'll show you some of the specimens that we have up there. I should mention that Farish Jenkins, from Harvard, was out to the quarry last summer and with his two assistants got down and very carefully looked at the entire quarry face. They found an impression of a small posterior part of a mandible of a rhynchocephalian that was toothless, the three little alveolae were there, so that is the first rhynchocephalian that's ever come from the quarry, to the best of my knowledge. Slides. Okay. We are looking from

the southeast up to the southwest, and the quarry is situated on top of a hill. Dinosaur Ledge is up here. This was what was taken off by the Carnegie Museum. So the old erosion level was at about this height. This is approximately forty feet up to here; the top forty feet was removed by the Carnegie Museum in years earlier. Again, the same view, the parking lot out front. The road comes up from around the hill here; the building has been fairly described as a cross between a barn and a greenhouse, a greenhouse because of the amount of light that we can let in so that the visitors can get their camera shots without any need for flash photography. Once they enter, usually the first impression of the visitor is one of awe. You wind up an easy access approach up to the second level, where you get the best viewing, and when you look out what you find or see is not this beautiful Camarasaurus skull but a mass of bones all jumbled together. This is Jim Adams, one of the two preparators. Both of the preparators, Jim and Tobe, have been there for twenty years. People have examined their work and feel that it's the equal of any that they have seen in any of the museums. The interesting thing about the Dinosaur quarry is that given the dip of seventy degrees virtually none of the thousand or so bones that are exposed on the quarry face today shows any degree of distortion. So as beautiful as Lance's skull is, and it is a beautiful skull specimen, it's amazing to me that these are all in perfect shape, virtually no distortion whatsoever. There was obviously varying degrees of decay before some of the specimens were washed in, and that, of course, rules out the possibility that we are looking at any catastrophic death. It is a catastrophic burial, as Dr. Hotton was mentioning earlier about ways to recognize that, and I think the specimens here confirm that. This is our most complete specimen right here, a large Camarasaurus on what we call the Camarasaurus Hump, the western part of the quarry. It was exposed even before the building was erected in 1958. Returning to the point that I had forgotten at the end of the talk, the biggest question the visitor has is, "Why don't you have a mounted specimen?" And I think that's important to the consideration here at the Fruita area, because the average visitor has been conditioned to expect at a dinosaur quarry a completely mounted specimen. And when they do not see it, many of them will not take the time, even with considerable help of the exhibits and what not, to try and figure out which bone goes where, among the somewhat disarticulated material at the quarry. That slide didn't seem to drop in; if we can drop that one in; the interest of this particular slide is that the technician is working on a very small Stegosaurus. There's a small Stegosaurus probably this high at the hips (indicating three feet) and about this long (indicating five feet). Here are the two femora of this small Steg.

DR. HOTTON: A little baby?

MR. KING: Yes. There are no plates on it. Both femora, one, at least one, tib, fib, humerus, radius, ulna, one small part

of the tail section, vertebrae, and I think that's about it. Anyway, one way that I have thought that we could have our cake and eat it too, given the limited amount of space and money, is to perhaps remove this small Steg specimen and mount it so that then the visitor would have his mounted specimen and yet it would be no more than this large on a table, and of course would be a highly unique specimen in terms of highlighting the Dinosaur quarry. It would not be, perhaps, as good as another suggestion that Jack McIntosh has made, which is, given the fact that the quarry is 75 percent Sauropod material, why not remove the material from the Camarasaurus Hump, the specimen that we showed earlier, and mount that in the walkway in front of the quarry. And then you would be able to continue the excavation, where there's obviously a good layer of bone behind the main Camarasaurus Hump. Let's see, just as a little background of the quarry, this is a small humerus of the Steg and here's the ulna and here's the radius. A very small specimen; very valuable. It's been up there for a number of years. Very few people, even paleontologists, are aware of it. And why something has not been done with it so far I really do not know.

Okay. For those of you who are not aware, the whole thickness of the main bone layer here is just 10 to 12 feet, so when I say remove the Camarasaurus, most of our good bone is about four to five feet down from the top, good hard sandstone layer in the middle of three proven layers of bones. The middle one is anywhere from four to eight times as concentrated as either of the upper or the lower. So in general we are using pneumatic tools to remove that outside layer to get back into the more prolific bone layer. And people very much tend to enjoy, like I said, this sidewalk superintendent operation of watching the actual rock being removed. Now, the expectations when they come here are that this is a flat line strata and that we are working straight down. The first thing that we have to convince them of is that this is a dipping, chuck full of dinosaur bone-bed, and that we are simply exposing back into a similar time line still on a seventy degree angle. Most people, again, asking without thinking, when they come in and see that two-thirds of the quarry is totally reliefed and the specimens are still out there, they want to know if we are going to take those materials out. We take very few specimens out. So the intent is to leave as much bone as possible on the quarry face. Within the laboratory, which is where we tend to spend our time in the colder months, people have a glass window that they look through and are able to see the blacksmithing operation; the specimens that are stored on the shelves, labeled, and the working out of some good jacketed specimens. This is a Glyptops, a turtle that was worked out about four or five years ago, quite a nice specimen. Three different genera of turtles are found in the quarry. After the Carnegie operation, the Smithsonian Institute came in and took out some very nice specimens. Then the University of Utah came in, continued the work where the Carnegie Museum had

left off because of a lack of support of funds from the museum after Andrew Carnegie had died, and collected the best, most articulated Allosaurus specimen that's yet been found, as far as I know. The skull wasn't prepared from the time it was taken out, '24 to '25, until the mid-60s when Jim Madsen brought it back to the preparation room. And because of the skills and the experience of Tobe Wilkins in working with that particular matrix, he prepared the specimen for them.

Another alternative to our mounted specimen dilemma is to perhaps reacquire that specimen from the University of Utah, since they now have material from the Cleveland-Lloyd quarry, which they prefer to have on display at the museum in Salt Lake. Again, this would not be a good activity to involve the average visitor in; it's just not something that lends itself well to people getting involved, what with children running around. It's difficult to manage and especially when we have the responsibilities for a finite number of bones that we are obligated to protect. Okay. I think that's probably it.

MR. BARRY: One comment that I would make is, you mentioned people come to Dinosaur with certain expectations, created from museums or whatever. What we have found at Cleveland-Lloyd is that we are, well, if you will, sort of sleeping with Dinosaur in that people come to us with expectations created at Dinosaur National Monument. They want, you know, to see an in-situ display very definitely. They want to see somebody up there working that display. They are expecting the same type of experience, and I'm sure that any quarry visitor in this region has got to take this into account. People do come with these expectations, and as you say, with 300,000 a year visiting Dinosaur, lots of the people that come are going to come after they visit Dinosaur, so a small quarry has kind of got to take that into account, you know, recognize that these expectations are going to be there, but yet not trying to compete or to duplicate the experience that you're providing.

MR. KING: I hate to categorize, but it would seem that the difficulty, the disappointment of the non-articulated mountain specimen is probably from the children's viewpoint, expressed to the parents, in the sense it's difficult for the youngsters to try and put the jigsaw puzzle together on the quarry face. The adults, having had their imaginations somewhat stunted, maybe, through years of work, seem to be the ones that are interested in, how do these guys get their jobs, how long have they worked here, what kind of tools do they use, what background do they have? The big words, the big names of the dinosaurs have more or less put up a little barrier between them and the specimens themselves, whereas the youngsters, of course, are the ones who know the names of the dinosaurs and are full of enthusiasm but can't really picture what the significance of the quarry is.

Dr. Lewis?

DR. LEWIS: Just an observation. In addition to the other institutions, the American Museum was, as you know, in there and collected and Nick Hotton's predecessor, Charles Gilmore, was a very good horse trader and so was Barnum Brown. And Brown was anxious to complete as nearly as possible a partial articulated skeleton of a Barosaurus, I think it was. And there was some real fast and fancy horse trading, fast when they were dickering, but it went on over quite a long time and Brown was still shaking his head when he finally reached a bargain.

MR. BENTON: Russ, you made an interesting comment there. The difficulty, I think, that's germane to this particular site, you made the comment that the difficulty of protection of the site, even though you live within a half a mile of it and virtually out of sight, I pose to you that we had 704,000 in 1976 who went right by on Highway 340, allegedly for some form of recreation purpose. You know, about twice the number that you're talking about, and you're talking about a displacement of, what, a mile and a half or two miles from 340. The difficulty of protecting that site, short of residential protection, is just beyond my wildest imagination. Because we find the same thing, of course, in other ways within the monument. Take your problem and multiply it by twice as many people, remove it from Highway 340 by a relatively short distance to a highly known area, and I think you have some idea of the magnitude of the difficulty of protecting this particular site. And I just pose to you that when you even have almost virtually residential employees, as you do at the Dinosaur, you still have a problem. And in this case we are talking about, I think one of the plans that John mentioned was sporadic or casual patrol. It's a really difficult task.

MR. RIPPETEAU: You're right on all this landscape out here where we have got all this authority, all of us in different ways, supposedly, and there's no way -- and yet John, in his proposal, referred to some kind of sensors, and we talked about that last night. John, is there any future in having some kind of sensing device out there that's really difficult to defeat?

MR. CROUCH: Well, there's two types that I know of. One, of course, is the impact sensor which may be practical for the removal of larger fossils because it would require some impact. And the second type of sensor that we have is a camera activated by body heat. The difficulty with the camera at that particular area is placement. As far as we could figure out, we would have to have a rather large lens and place it on the other side of that small canyon focused over the entire area. We have been looking at both of these. There has been some success with the implementation of impact sensors in California, but it was due, as I understand, to the unique placement of these sensors. We do have a complex problem here; I think we'll have to evaluate both the impact and photographic sensor.

DR. RIPPETEAU: How about TV cameras, real or fake, with little lights on them like they are being scanned?

MR. BENTON: We put so much money into the preservation of a museum in North Dakota it almost got to the point where the cost benefit ratio equated out by putting a resident employee on site. And I still pose to you that in the Civil War areas, the corn, bean and squash areas in the southwest, if you're really talking about high level, really good protection, there really is no substitute for an in-residence employee. And surprising enough, they don't cost that much. You're talking in terms of your first one time cost of somewhere around thirty thousand. And the maintenance cost of about ten thousand per year. And assuming a man and wife couple, which works well because they tend to stay home nights, that becomes a relatively minor protective device as opposed to some of the more esoteric things.

DR. RIPPETEAU: I have got one last suggestion, and that is that all this hairy stuff from Vietnam that was parachuted down, and anything that is living or walks by this stuff, worked.

MR. BENTON: They claimed mines worked, too.

DR. LEWIS: I would like to offer one suggestion, which I think is perfectly obvious. But the best protection for the Fruita site is to get in there and excavate it promptly.

MR. CROUCH: Thank you.

DR. ROBINSON: I would like to point out that the concept of a live-in person is one that's been used for hundreds of years in Europe. They are called concierges, and most of the museums I know of have them and they double as janitors or what have you. When you go in the Paris museum and you go past the very nice aroma of his wife's cooking . . .

MR. BENTON: It does work.

VOICE: It brings up a much larger problem, to identify or not to identify. The minute we put a fence around that area, it becomes a known point that extends far beyond paleontolofy and archaeology. We cannot put a live-in resident on all of these sites, and we are faced with the dilemma of whether to even identify it.

MR. BENTON: The autonomy of that particular site is known throughout the valley. You could go to any high school kid anywhere in the Fruita area and almost any adult that walks up and down the valley, and he can take you to that site. I think that the district's decision to fence that thing was critical. I think they did a super job on it because the site is known and we have gotten

enough feedback from people, bone hunters in the monument, that have been repelled by those signs and by that fence. They way, "Gee, they've closed that to us now. Where can we go from here?" And of course, we send them over to Dinosaur.

MR. CROUCH: Thank you. Bruce?

DR. RIPPETEAU: I just have one last comment that you and Tom and Bob might want to look into. Can't you guys just call up the Defense Department and ask them how would they solve a problem like this? Do you fence public lands? This little light bulb area that we wish to protect really is not feasible to have people living there. You know, can't you call upon another branch of the government?

MR. BENTON: They have, as a matter of fact.

DR. RIPPETEAU: Well, has there been any result?

MR. BENTON: Yes, we have control of the Mississippi test center that we inherited from NASA and there's some pretty esoteric stuff coming out of that facility, out of the NASA wars and the Army wars. It's been primarily towards the Civil War areas in which pot hunting goes on to a tremendous extent, so there is some very esoteric stuff. The one thing that we know, the Defense Department has more money than the Interior Department, and some of these devices are incredibly expensive. You know, they say, "Gee, yeah, we can protect this hundred acres to a tremendous degree." They use some of the same stuff around Camp David up at the Catoctin Mountains there. But I just point out to you that the costs that they throw at us are just about a trade off between people.

DR. RIPPETEAU: What you have got to create is sort of a guerilla army that's operating from areas that need to have all of the surveillance, and have them pay for it.

MR. ERIKSEN: I don't see how you can deter one sort of evil by the start of another. I mean, you can get into something where we are all going to suddenly pay for in the future. You'll have a little bit of this destruction now, which really bugs me, too. But you have got to be very careful about what you do to protect all of this.

DR. ROBINSON: Is the Fruita site worth setting aside all this money and people, like at Dinosaur? Or is it something that people should simply go in and salvage as soon as possible all of the material available to them? I think their talking about protecting the sites is, in a sense, getting ahead of the game until it's decided what kind of utilization should be made of the site.

DR. LEWIS: I would also like to suggest that the ingenuity -- not even of, but especially of school children, is something that we shouldn't overlook. The Department of Defense, with all the resources at its disposal, you may be sure that everything possible to preserve the security of the anti-missile and the anti-high level bomber attack possibilities against the city of Washington, D.C. was ringed by defense missile installations. And in Naval Intelligence we had some doubts that all these things were effective. So with the full knowledge of the military eschelons that were responsible for those installations, we visited, openly visited, the installations with some students from the Naval Academy Postgraduate Intelligence School. They had all the sophisticated devices, fences, guard dogs, guards, high density guards, and we warned them in advance that we would try, as I say, penetrate their security. And in less than a week we had got in and gone through the whole thing and they weren't aware of our presence, having been forewarned that we were going to try it. Just some enterprising, resourceful young men. So never get a false sense of security, no matter what you have there. And probably the best thing is a couple of paleontologists like the ones who have been excavating out there, camped in tents or trailers right on the site until the stuff is out.

MR. CROUCH: Very good.

DR. LEWIS: This is a practical observation. I hope it's correct, not misleading.

MR. BARRY: If you're going to think of a sensor, who's going to monitor the sensors week-ends and evenings when they are going to be most needed to be monitored? Then you have got, I would say, from getting personnel out to the site to see what's going on, you have a lag time of half an hour to forty-five minutes.

MR. CROUCH: We have, most of the year, as I understand it, a fire crew that monitors electrical equipment for receiving calls 24 hours a day. I think this is in the summer; I'm not sure if it's in the winter. This we would have to look at, yes.

DR. LEWIS: I would be willing to bet if you had surveillance television installations out there that possibly within a week, and certainly not more than a fortnight, some fence in Denver would be trying to sell them.

MR. BARRY: To some extent, when word got around that sensors were out there, it becomes a challenge to go in to try to get bones without getting caught.

MR. CROUCH: We have a problem in that area and it's been confronting cultural resources, history, archaeology, for years. And there's really no pat system for protecting our resources.

MR. BARRY: Another thing I would mention, there's a certain amount of research that's been done on means to reduce vandalism of recreational sites. A lot of it, I think, is applicable to this site and that very definitely should be looked into. The very simple thing is that a site that has been vandalized will be vandalized more. A site that's obviously well managed is going to be vandalized very little. I think that's what happened at Cleveland-Lloyd. We have put in an appearance in spite of the fact that there are periods where it's not checked for three or four months. We have had virtually no vandalism problems.

MR. CROUCH: These problems could be addressed in detail this afternoon. And of course, we are going to solicit your recommendations concerning all aspects of this quarry. Do you have a question?

MR. SHANKS: Through education, in sophomore biology or geology, you just say to the children, when you find something like this don't try to take it out yourself because you don't know what it's about. Find somebody that does, you know, try to stall off anybody that has this idea. Because you'll get as much credit for finding it and you'll really learn something from it. You might even get your name partially attached to it as part of the scientific name. Try to get this accross to them and this, I think, will help. They'll go home and share this with their friends or their parents. And if their parents are rockhounds or bonehounds, sometimes a kid will go to their parents and say, "Hey, this bone or this part isn't ours, so . . ."

MR. CROUCH: Very true. All right. Now, we are going to have our concluding remarks by Mr. Owen. We are going to adjourn after his remarks and I want to thank all of you very much. Most of you will be back this afternoon. Mr. Owen.

CHAIRMAN: The eight consultants that I named yesterday morning are, of course, the work group that I hope will put their heads together and come back with recommendations to us. Over the lunch hour, we will refine the subject matter areas that we believe to be -- that you people can address, and as a way of getting this started, John and I and Gary will get together over the lunch hour, then, and make tentative assignments of the eight consultants to these various subject matter areas, come back and present that to you. And at that time see if that meets with your approval or if we need to make adjustments in that. Then we can allow you a time period to work and to develop some recommendations. And then each group can bring their recommendations back to the entire group, review them and hopefully get a consensus. If not, why, we'll work that out when we hit it. I have been assured that paleontologists always agree on everything anyway, so that may not be too much of a task. So let's try that approach.

I particularly want to thank those that have contributed their time and ideas. Bob Benton, the Superintendent of the Monument out here, I particularly appreciate you and Sue coming over. And Bob Barry from the Price district. Bruce Rippeteau, state archaeologist, and the others who have sat in and contributed ideas to the discussion. We appreciate that very much and we'll certainly make the proceedings available to you folks when we get them all completed.

(WHEREUPON, the proceedings were adjourned.)

CERTIFICATE

I, John D. Powers, Certified Shorthand Reporter and Notary Public, do hereby certify that I recorded the proceedings in the foregoing hearing, that the foregoing transcript was reduced to typewriting from my shorthand notes under my supervision and direction, that I have carefully compared the foregoing transcript with my shorthand notes, and that the foregoing transcript is a true, accurate and complete record of the said statement to the best of my knowledge and belief.

IN WITNESS WHEREOF, I have set my hand this 7th day of June, 1977.

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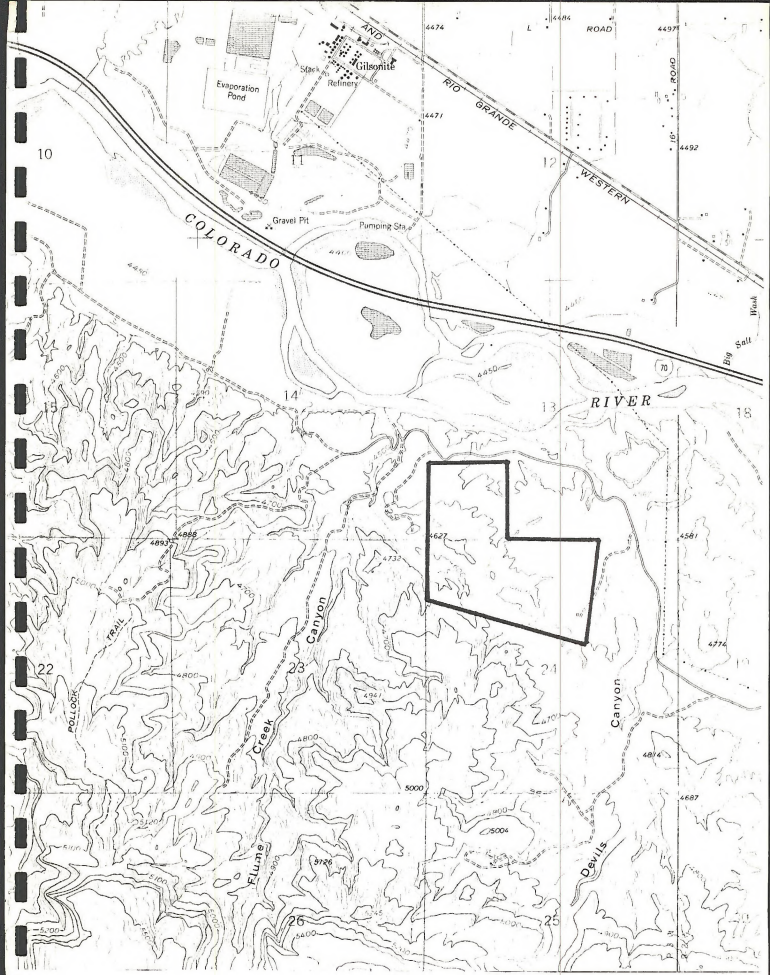
John D. Powers, C.S.R.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4474
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4492
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4627
4581
4774
4814
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4885
4893
5000
5004
3726